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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVII.—No. 399.

HOW TO RENDER COAL MINING SAFE.

THE recent mining catastrophes in this country have apparently had the effect of rousing the public interest to the fact that it is high time for some effective measures to be taken to render working in coal pits a safe occupation, or at least less dangerous than it has been in the past. Mining is about the only enterprise in which, year after year, the same callous indifference appears to exist respecting the safety of those toilers on whose labours so much of the commercial welfare of England depends: and we again repeat that strong measures should, without further delay, be adopted for the better protection of miners from the all too frequent and disastrous explosions which unfortunately give little or no warning of their coming. Whilst advocating the fair trial of everything which human ingenuity can suggest, and which competent authorities shall decide to be worthy of employment for rendering these underground labyrinths comparatively free from danger, we cannot ignore the fact that those whom we wish to protect are themselves the primary cause, in many instances, of the calamities which we have so frequently to deplore. The recklessness of the miner is proverbial, and disaster upon disaster have really no effect in teaching him to exercise care and caution whilst in the pursuit of his risky and arduous occupation. Give him the most effective of safety lamps and he will do his best to render useless the efforts made by his employers for his own good.

The too general employment of *naked* lights, a practice which should long since have been abolished, is a grave mistake for which, however, the miner is not altogether to blame, for their use is countenanced in some districts by the officials in charge of the mines.

The Pendlebury accident is attributed solely to the foolish habit to which we have just alluded; and with this catastrophe still fresh in our memories, we should at least strive to secure the abolition of this most fruitful source of danger.

It goes without saying that the majority of our readers are convinced that immunity from explosions can only be made absolute by the employment of the electric incandescent lamp, but we must not in our championship of electric lighting, forget that considerable difficulties are entailed in securing, for a mine installation, freedom from accidental interruption. Blasting operations, the falling in of roofs, falling coal, a misdirected blow from a pickaxe, &c., might easily be the cause of many broken lamps or even the breaking of a circuit. For mining purposes, therefore, we feel assured that the most practical

arrangement will be, as now, a portable light, but without the same attendant dangers. The lamp must be easily carried, of but little weight, readily managed, not easily disarranged, quickly repaired, and equal to a demand of several hours' illumination without attention, be it electric or otherwise; and, above all, it should be of a construction which, like "Griffiths' safes," cannot be tampered with.

The field for invention in connection with coal mining is a wide one, and on the man who can reduce the list of fatal pit accidents by even a small percentage a mine of wealth ought to be showered.

It is devoutly to be hoped that amongst the number of competitors for Mr. Ellis Lever's prize of £500 for the best electric safety lamp, there will be at least one thought worthy, on this the second occasion of Mr. Lever's munificent offer, of the award.

There is, however, a matter of still more importance than the actual lighting of a coal mine which demands consideration. Would not these subterranean operations be carried on in comparative safety if a constant and infallible means of indicating, to those in charge at the surface of the pit, the exact conditions existing in all parts of the mine, could be secured? We think so.

If we can by any means be made aware of a coming danger, we are in a position to take the precautions we think most fit to meet the threatened calamity, and such means appear to us to be forthcoming in a manner not heretofore approached, by the employment of the apparatus described in our other columns.

It has been said, with how much truth we do not know, that the managers of coal mines are as a body averse to the expenditure which would be incurred in fitting an extensive mine with apparatus more costly, but more perfect, in exchange for the crude means now employed; but we can scarcely believe that monetary considerations take preference before the lives of their workmen.

At all events, we trust the time has now arrived when decided steps should be taken, and something definite accomplished, in the direction of rendering coal mining a safe operation; or must we wait until a few mine owners are numbered with the slain?

Experiments in Long Distance Telephony.—Telephone experiments of an important character were made on Thursday last week by officials of the Post Office between Uxbridge, 15 miles west of London, and Liverpool. The experimentalists were Mr. Woods, of Oxford, and Mr. F. E. Evans, of Birmingham, superintendent engineer, the latter having charge of the Liverpool station. The Gower-Bell telephone was used for the purpose, and connection was made with a new line of telegraph. The distance between Liverpool and Uxbridge is 200 miles, and experts were doubtful about the result of the experiments, this being the longest distance ever tried in England for telephonic communication. The test applied, however, is said to have satisfied the operators that it is possible to communicate between centres twice that distance apart. A double wire was used in this instance and conversation was distinctly audible, and Mr. Woods, the operator at Uxbridge, acknowledged that though he had been very sanguine of success, his expectation had been fully realised.

DEFECTS IN ELECTRICAL MEASURING
APPARATUS.

WE have recently, says M. Hospitalier in our Parisian contemporary *L'Electricien*, had occasion to point out the excessive discrepancies presented by different measuring apparatus calibrated by various makers and compared at very different times afterwards. We are now about to consider these causes and to show that as far as re-calibrating is concerned the measuring instruments hitherto employed are far from having reached perfection.

Whatever may be the nature of the electric magnitude to be measured, whether current strength or electromotive force, we find always in the measuring apparatus two essential elements:—1. A galvanometric circuit traversed by the current and producing a certain electro-magnetic action. 2. A directive force counter-balancing the action of the current and determining a given position of equilibrium for each current strength. In order that the standardising, which we assume to be accurate at the outset, may remain permanent, both the circuit and the directive force must remain permanent and fixed.

Variations of the Directive Force.—The causes of variation of the directive force are the most numerous and important. We will examine them in succession, according as there is employed the terrestrial magnetic field, a directive magnet of greater or smaller power, a spring or gravitation.

The Terrestrial Magnetic Field.—It is absolutely impossible to depend on the indications of standardised measuring apparatus in which the terrestrial magnetic field serves as a directive force, especially when the apparatus has to be employed in different localities. Under certain circumstances we have seen the horizontal intensity fall to 0.15 of a centimetre-gramme-second unit whilst at the park Saint Maur, according to M. Mascart's determination, it was 0.193 unit. This is, therefore, a variation of 20 per cent. in the directive force, and causes the apparatus to furnish indications so much the greater the weaker is the field. The apparatus in which the directive force is derived from the terrestrial magnetic field require, therefore, frequent re-calibrating, especially each time that they are removed.

Directive Magnets.—We have many times signalled the causes of variation of magnets, variations which may reach 10 per cent. on the absolute value of the magnetisation. The causes of these variations are numerous. They depend on the nature of the steel, its texture, its temper, the manner of magnetisation, &c., &c. In general the directive magnet tends to become weaker, and the apparatus to *advance*, that is, to give indications higher than the real value of the current which is being measured.

Springs.—Springs, especially if made so long that their torsion is only excessively weak are more permanent and more constant than magnets. Hence the indications of electro-dynamometers are more comparable than those of magnet-galvanometers, without, however, being absolutely constant.

Gravitation.—Gravitation is the most constant force at our disposal for obtaining a permanent directive force in a galvanometric measuring apparatus. Hence the balance electro-dynamometers are the most exact measuring apparatus. But this advantage is often compensated by an inconvenience resulting from the use of permanent magnets, as, *e.g.*, in Lippmann's ampèremeter.

Variations of the Circuit.—The variations of the circuit traversed by the current to be measured introduce into the permanence of apparatus perturbations which are not sufficiently taken into account, and which are far from being unimportant. The chief causes of variation are the form of the circuit and its resistance.

Form of the Circuit.—M. Lippmann's ampèremeter furnishes us with the most striking instance of the influences of the form of the circuit upon the permanence of the standard. It is known that in this

apparatus the current to be measured must traverse a narrow stratum of mercury, the thickness of which does not exceed the tenth of a millimetre, and that the difference of level produced, all other things being equal, is inversely proportional to this thickness. Hence a difference of $\frac{1}{100}$ of a millimetre produces deviations of 10 per cent. in the observation. If we take into account how expansion, heating, the attraction of the polar masses, &c., may cause this thickness to vary by the quantity indicated, we see how difficult it is to obtain a Lippmann's ampèremeter which is both permanent and sensitive.

The Resistance of the Circuit.—The resistance of the circuit comes into play especially in voltmeters in which the resistance ought to remain constant. Unfortunately most of the bobbins of voltmeters are of copper wire, and, according to the place where they have been fitted up, the season, &c., their temperature undergoes fluctuations which reach 20°–25° C. There is, by this fact alone, a difference of 10 per cent. in the indications of two identical voltmeters one of which, *e.g.*, remains in the machine house whilst the other is placed outside exposed to a temperature of 5°–10° C. This cause of error becomes still more important if the apparatus presents an insufficient resistance, and if it is left for some time connected with the circuit it becomes heated by the passage of the circuit and its indications diminish more and more: *it retards*.

Such are the principal causes which contribute to render the permanence of standardised industrial measuring apparatus illusory. There are secondary ones upon which we think it useless to insist. If we connect these causes of error with those resulting from the form of the currents employed, if we see that these causes of error may either accumulate or compensate each other according to particular cases, we can explain the great discrepancies presented by the figures presented by different inventors and experimentalists, and we can understand that it is not sufficient to refer to the indications of standard measuring apparatus obtained from respectable and accurate makers. The experimentalist must learn how to make use of such apparatus.

A SIMPLE FORM OF INFLUENCE
MACHINE.

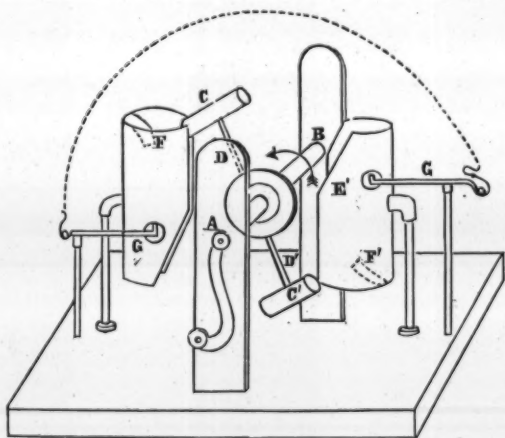
By JULIUS ELSTER and HANS GEITEL.

INFLUENCE machines have found entrance everywhere as means of instruction on account of the undeniable advantages connected with the rapid production of great quantities of electricity. However, their educational value is considerably reduced by the circumstance that their theories offer the beginner considerable difficulties. To remove these it is advisable before their introduction to show on a comprehensible apparatus the mutual reinforcement of two conductors charged with opposite electricities.

For an understanding of the simple apparatus which we are about to describe, and which approaches in its construction Thomson's "replenisher," it is merely necessary to be acquainted with electric influence and with the fact that electricity has its seat on the surface of conductors. The arrangement of the apparatus is as follows: on the axle, A, B, turned by a crank, there are fixed six metallic conductors (the figure shows only two), C, C', made of corks covered with tinfoil. They are attached to the insulating supports, D, D', in a plane perpendicular to the axle. When revolving, these pass freely by two fixed insulated metal cylinders, E, E', open at both ends, which, in order to give a passage to the supports, D, D', are cut open longitudinally on the side turned towards the axis of rotation. At the same time they are cut off obliquely on the side inclined towards the axis of rotation, at the parts at which the movable cylinders, C, C', issue in revolving in the direction of the arrow, in order, at the moment of

emergence, to leave the greatest possible interval between the movable conductors, C, C', and the fixed ones, E, E'. These latter carry at the ends not cut obliquely two metal springs, F, F', turned inwards, which project so far that they touch the movable conductors, C, C', when revolving. There also pass two other contact springs, G, G', through two circular apertures left in the fixed conductors (about the middle) into interior of these fixed conductors where they likewise come in contact with the movable conductors. These two springs are in conductive connection with each other, or connected with the earth. The action of the apparatus is as follows:

Suppose that a certain charge, $+e$, is communicated to the cylinder, E. As soon as, on turning the axle, one of the movable conductors projects so far into the cylinder as to touch the conductive spring, G, it is rendered negatively electrical by induction; on revolving further the spring, G, is first left behind; the conductor then, charged negatively, issues completely from the first cylinder and touches the spring, F', of the second. It remains so long in contact with this until it has completely advanced into the interior of the cylinder, E', and has therefore given off its charge to it almost entirely. E' has now a negative charge. If the movable conductor now comes in contact with



the spring, G', it is rendered positively electrical by induction, and on further rotation conveys its charge in the same manner to the cylinder, E, increasing its tension. So a mutual intensification of the charges proceeds quickly as far as the attainable maximum. This cannot here be very high since an efflux of opposite electricities very soon takes place from the springs, G, G', leading to the earth, as may be detected by the odour of ozone, and tufts of light visible in a darkened room. The apparatus is self-exciting. If two electric pendulums are fixed to E and E', the rapid increase of the charge is plainly perceptible.

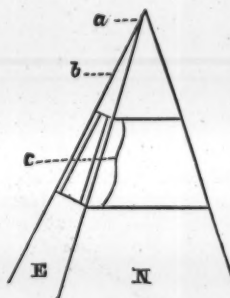
Of course the apparatus would be considerably more efficient if, instead of the metal cylinder fixed radially to the axle, we used a revolving glass disc with sectors of tinfoil, and replaced E and E' each by two parallel glass plates coated externally with tinfoil. But then we should essentially return to the construction of Töpler's machine, for evidently only a step is wanting to dispense with the charges of the solid conductors, E and E', and in their stead to introduce a spark interval in the metallic conduction of the two springs, G, G', which must now, of course, be insulated. If, finally, also the tinfoil sectors of the revolving disc are omitted, and if points are substituted for the contact-springs, we have the essential features of Holtz's construction. The connection thus indicated between the different forms of the influence machines has been already fully explained and theoretically founded in a treatise by Veltmann, "Theory of the Influence Machine,"* to which we refer.—*Annalen der Physik und Chemie*.

* Veltmann, Pogg. *Annalen*, 151, p. 513; 1874.

THE WASHINGTON MONUMENT AND THE LIGHTNING STROKE OF JUNE 5th.

THE following short statement of the facts of the recent injury to the Washington monument by lightning is given in *Science*:—On the afternoon of June 5th a thunderstorm of no unusual character passed over Washington. At about 15 minutes past three there was a single burst of thunder of some violence, which was about the only notable electrical disturbance of the afternoon. Although it had successfully passed through disturbances apparently much more violent on one or two previous occasions, this time the monument was "struck," and some damage done to one of the stones near the apex. Two men who were inside of the structure, at the base, describe the sound produced as resembling the simultaneous discharge of a great number of cannon, and declare that the "whole monument trembled." Two others were in a small wooden building, used as an office, near by. One of them was looking out of the window, away from the monument, toward the north. He affirms, in the most positive manner, that he saw a ball of fire, which he says was as large as his fist, coming directly towards the window out of which he was looking. Both he and his companion (who was not looking out of the window, and who did not see the ball of fire) seem to have felt something of the usual effect of a shock. Those who were within the monument say they felt no unusual sensations except those produced by the noise.

When the monument was examined from the ground with the unaided eye, no injury could be detected. On applying a good telescope, however, it was seen that one of the stones just below the capstone was split from top to bottom, the crack produced being about four feet long, and it was open to the extent of about two inches. A small corner of the lower corresponding angle of the capstone had also been carried away, this doubtless resulting from the opening of the crack in the stone upon which it rested.



The appearance of the apex is fairly represented in the sketch, in which (a) represents the aluminum tip, (b) the capstone, and (c) shows the crack in the stone in the next lower course.

Col. T. L. Casey, U.S.A., the engineer in charge of the construction of the monument, requested Profs. Rowland of Baltimore, Newcomb of the U.S. navy, and Mendenhall of the signal service, to examine the monument, and recommend such additions to the present arrangements for protection from lightning as would seem to them necessary and sufficient. It was ascertained on examination, that, with the exception of that shown in the sketch, the monument showed no evidence whatever of having received the stroke. A careful examination of the tip of the aluminum apex has not yet been made; but it seems likely that it will be found to be somewhat blunted by fusion, as is so often the case even where no other effect of the stroke is to be seen.

This aluminum pyramid is secured to the capstone by a heavy copper bolt one and a half inches in diameter. From the end of this, four copper rods, each three-quarters of an inch in diameter, are carried

to the extremities of four heavy iron columns extending to the base of the monument, inside of which the elevator runs. As originally put in, these rods are bent out towards the four corners of the pyramid near which they run on their way to these iron columns. Just where one of these is nearest to the angle of the pyramid, and hence nearest to the outside of the structure, the rupture occurred; and to this must doubtless be attributed the localisation of the stroke.

The damage done to the monument is in reality very small, and can easily be repaired; but the accident is exceedingly instructive to those interested in lightning protection. The conducting power of the interior seems to be ample for any discharge which could possibly occur, and no evidence appears of any weakness in this respect; but it is evident that the aluminum apex alone does not possess sufficient collective or distributing power, and the improvements suggested by the committee will doubtless be in the direction of increasing that power by the addition of more metal.

REGISTRATION OF ELECTRICAL MEASUREMENTS BY PHOTOGRAPHY.

Messrs. Trowbridge and H. V. Hayes describe in *Silliman's Journal* a photographic method which they have devised for registering in a continuous manner the variations of the electromotive force of a battery.

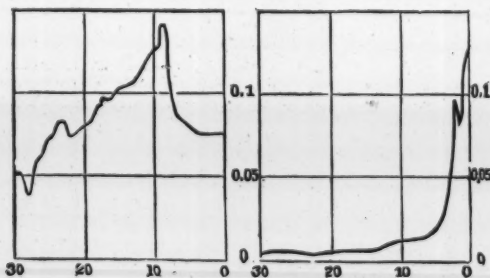
The current of the battery traverses a tangent-galvanometer of a small number of coils, having a needle fitted with a mirror.

This mirror collects the rays of a gas-burner passing through a vertical slit in a screen and reflects them upon a sensitive paper placed in a camera.

The aperture of the camera is a horizontal slit, the intersection of which with the vertical ray from the screen gives merely a luminous point. The photographic paper is stretched on a sliding frame the uniform displacement of which from above downwards is effected by means of a cord rolled upon a small drum, which is set in motion by clockwork. A fixed concave mirror arranged quite close to the needle of the galvanometer reflects also a portion of the vertical ray of the screen.

It is regulated so that its image and that of the movable mirror coincide when the needle is at zero.

We see immediately that the ray coming from the fixed mirror describes a right line, whilst the ray reflected by the movable mirror describes a curve the ordinates of which measure at every instant the strength of the current which traverses the galvanometer.



Figs. 1 and 2.

Fig. 1 represents the diagram given by a modified form of the Trouvé battery.

The experiment lasted 30 minutes with an exterior resistance of 5 ohms.

The commencement of the curve indicates the strength of the current at the moment of closing the circuit. It will be remarked that this only reaches its maximum at the end of 10 or 12 minutes. After this moment it goes on decreasing.

The fig. 2 is the diagram corresponding to an exte-

rior resistance of 10 ohms. Under these conditions we obtain at the moment of closing the circuit an energetic current which, during the first 5 minutes, falls rapidly to about one-sixth of its initial value.

Knowing the distance of the galvanometer from the sensitive paper we proceed, just as with an ordinary galvanometer scale, to deduce from an ordinate the corresponding value of the current strength.

By making use of the two diagrams we can determine the electromotive force of the battery according to Ohm's law, taking the currents corresponding to the moment of closing. Knowing, then, the electromotive force, the current and the external resistance, we can calculate the internal resistance.

This resistance will be that of the liquid contained in the battery only at the moment of closing, for immediately afterwards the variations of the electromotive force due to polarisation, and the changes of resistance arising from electrolytic action, are so many additional causes of error.

Still, as the variations of electromotive force produced by polarisation are far more rapid than the changes of resistance, we commit only a slight error in comparing very near points in those parts of the curve where the variations of current are the most considerable. During the fraction of a minute while we operate thus, the variations of resistance may be entirely neglected.

The figures which we reproduce from *La Lumière Electrique*, have been selected among many others to show to what considerable variations certain batteries are subject, and thus to make apparent the utility of a method which enables them to be taken account of.

We can study, according to these diagrams, the variations of electromotive force and of internal resistances, when working with different exterior resistances.

It is evident that the same method is applicable to the observation of the oscillations of a needle with a short wire, and for the study of the gradual heating of a thermo-electric battery.

We can thus study the propagation of heat in the interior of a bath.

AN ELECTRICAL FIRE DAMP INDICATOR.

THE name of Sir Humphrey Davy is, amongst electricians, associated almost solely with his notable experiments with the arc electric light; but amongst the masses he is more generally known through his researches respecting the reasons whereby explosions are so frequently occasioned in mines, and in the means to be adopted for lessening the risks to human life therefrom. The outcome of his long and patient investigations resulted in the invention of the well-known Davy "safety lamp," the construction of which need not be entered upon here. That this has served the purpose for which it was intended will not perhaps be admitted on all hands, but where it has failed we should be inclined to place the blame, in the majority of cases, not upon its use, but rather upon its abuse. We will not dwell here upon the fact that all classes of the community are rapidly recognising the importance of the immediate adoption of some more reliable methods than at present exist for warning miners of the unseen dangers by which they are constantly surrounded; these matters have received their due meed of attention in our other columns.

Our purpose is to present to our readers an arrangement for detecting the presence of the dreaded and fatal "fire damp" in a manner which to us appears to present such remarkably good prospects of success, that we hope it may soon be tested in this country with as good a record as it has already achieved amongst our transatlantic brethren.

It will readily be assumed that electricity plays the principal part in the apparatus we are about to describe,

as we believe it will do in many of the future operations connected with mining.

It is generally considered that the principal thing needed to secure immunity from explosions is a fore-warning of the threatening danger arising from an accumulation of "fire damp" in spots frequented by the miners. This would naturally necessitate an incessant inspection of every part of the mine, but this, if carried out by human beings, entails certain grave objections.

The first, which is a matter of cost, is the least important; the second is the impossibility of securing untiring watchfulness by human agency. We must therefore replace the failings of mortals by an automatic contrivance, which, if not infallible, shall go far towards securing that feeling of safety which is so desirable an object in the working of coal mines.

Hitherto the apparatus devised have been more or less successful as mere detectors of fire damp, but they have generally been of too delicate a character for rough usage, or have shown themselves unreliable over an extended period.

To meet these objections an electrical apparatus has been devised by Dr. Kitsee, of America, to indicate the safe or dangerous condition of the atmosphere in the pits; this is entirely under the control of the works manager and reports its own condition, i.e., whether it has been neglected, tampered with, or is in good condition.

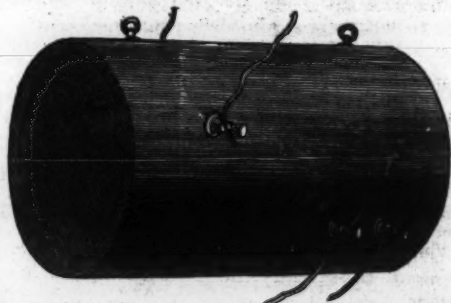


FIG. 1.

The first instruments employed were of the kind shown in figs. 1 and 2, and we will describe these for the sake of making our article the more complete, and also for the purpose of showing the improvements made in the apparatus of the most approved type.

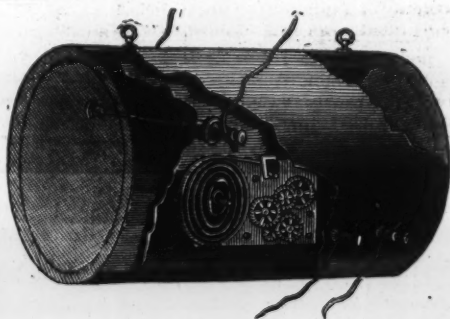


FIG. 2.

The apparatus depends on the fact that an explosive mixture of air and fire damp may be fired by the passage of an electric spark, in a box having wire gauze walls, that the explosion so produced may be confined to the interior of the box, and may be made to indicate itself by setting in motion a clock-work movement which reports to the office or engine room.

The apparatus consists of a double metallic box, of which the form is a matter of indifference; the drawing shows a double iron cylinder, the external one being four inches in diameter and six inches in length; two opposite faces are double walls of wire gauze. A clock-work is placed between the walls of these two boxes or cylinders.

The wire gauze is double, and the double walls are separated by a little space, because fine coal dust will settle on the exterior. This coal dust will not penetrate to the interior gauze, within which the explosion is confined, and the exterior gauze may be cleaned at such intervals as may be required by the peculiar circumstances of the mine.

Within the double box are arranged two insulated wires, separated by a little space, and connected by well insulated wires with the terminals of a Ruhmkorff coil or other apparatus, capable of producing an electric spark, so that a spark may be produced in the box at pleasure. Close to the wires is stretched a silk thread, one end of which is fastened to and draws back a small hook that holds in check the clock-work. By means of a spring the hook is drawn in and the clock-work released when there is no tension on the thread. The thread is then drawn taut, and its free end clamped by a small screw placed opposite the spring and hook.

The clock-work is connected, on a closed circuit, with an ordinary telegraphic battery, in whose circuit are annunciators in the engine room or office, and the spurs of the clock-work are so arranged that a different signal shall be given by each box as soon as the clock-work is set in motion.

The indicators are suspended at the roofs of the galleries on hooks or by clamps, and the atmosphere of the mine then circulates freely through the wire gauze. At regular intervals, and automatically, by means of a clock in the engine room, or by an apparatus under the control of the manager, sparks are sent through the whole series of boxes in the mine. Should the atmosphere in any gallery or working be explosive, an explosion will take place in the box situated in that locality; the silk thread will be burned, and the released clock-work will be set in motion. At the same instant the explosion and its location will be reported by the annunciator, and means may be adopted for the ventilation of that portion of the mine.

All the electrical conducting wires connected with the instruments are thoroughly insulated, and are protected from accident by their location, or by being enclosed in lead tubes. As work is carried on, and the mine is extended, additional indicators must be introduced and located at such points as may be deemed advisable by the manager. Where the long-wall system is adopted, and worked-out chambers are filled up, the indicators from such portions of the mine may, of course, be removed, and may be placed in new workings.

The principles underlying the above described instrument were thoroughly investigated by various authorities and reported to be correct; amongst others, the sub-committee of the Committee on Science and Arts of the well-known Franklin Institute of America, decided that their experiments conclusively proved that the indications of the apparatus were entirely trustworthy. There remained then nothing but its practical application to demonstrate fully the value of the invention. The use of the mine of the Moundsville Coal Company was therefore kindly granted for a practical trial, and Mr. O. A. Veasey, the State Mine Inspector of West Virginia, was invited to attend and witness the demonstration.

The instrument already mentioned were employed for the purpose, with this modification, instead of a double iron cylinder only a single one was used, the clock-work being protected by a simple brass cap. This indicator was placed in the mine and connected by the necessary wires, and the trials were witnessed by the miners and the various officers of the company, and by the State Inspector. The results are best shown in the following letter signed by Mr. Veasey, the secretary, and the superintendent of the company.

"We, the undersigned, hereby certify that we have witnessed a practical test in the mine of the Moundsville Coal Company of the electric fire damp indicator, and we are of the opinion that the introduction and use of the instrument in mines in which fire damp is given off would be a great safeguard upon the lives of the men working therein, and upon the property of the

mine operators. The test witnessed by us in the above named mine was a perfect success."

Although the results of the practical tests were highly satisfactory, it was nevertheless seen that there were several points about the instrument which it was desirable to improve and perfect so as to render it thoroughly automatic. At the trial it was observed, and clearly demonstrated, that whilst at some points the uppermost layers of the gas four or five inches from the roof were in an explosive state, at other places it was not so until a foot or more from the roof. It was therefore seen that an instrument to be perfect should be so arranged as to encompass the entire volume of the gas so that it might respond no matter what portion of the stratum might be explosive.

It was decided that the apparatus ought to be so graduated that the officials in charge of the mine should receive exact information, not only as to the locality,

placement necessitated human attention more or less frequent.

A third point was the abandonment of clock-work for a more simple and continuous device.

After much careful study and experiment the inventor has produced the perfected indicator shown in fig. 3. It consists of a semi-circular or V-shaped box or trough, the cover of which is perforated with circular orifices about six inches in diameter. These are covered with double walls of wire gauze separated from each other by about half an inch. The wire gauze walls are protected from damage by falling coal or other accidental injury by a perforated cast iron shield. The instrument is placed in the mine in a vertical position in an excavation prepared for its reception. In each compartment of the trough is a little instrument, as seen in the cut, consisting of a circuit-breaker in combination with a thermostat.

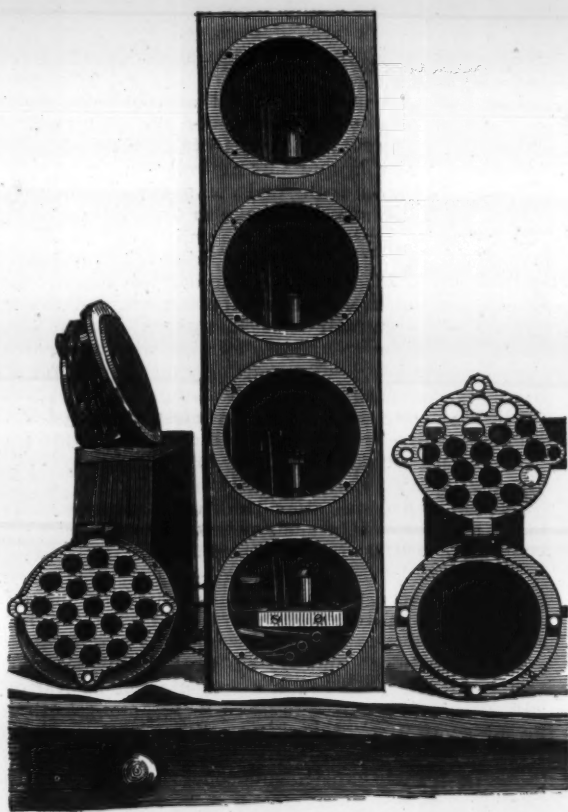


FIG. 3.

but also as to the height of the explosive mixture. For this reason the instrument was divided into compartments, as seen in fig. 3. To this point is attached some importance. If the furthest box or boxes should show from the topmost compartment gas of an explosive character in that locality and very close to the roof, it might not be necessary to interrupt the work going on, a warning to the workmen to be careful, or to avoid *pro tem* that portion of the mine, perhaps sufficing. If it were merely announced, however, that explosive gas were present there without an exact intimation as to its height, prudence would immediately command a cessation of work until the gas be removed. In fact, this arrangement will give the officer in charge a scaled statement as to the character of the gas, if any, and he can then take the requisite steps, dictated by prudence and experience accordingly.

The thread which, when burnt, set loose the clock-work spring, was also considered a defect, as its re-

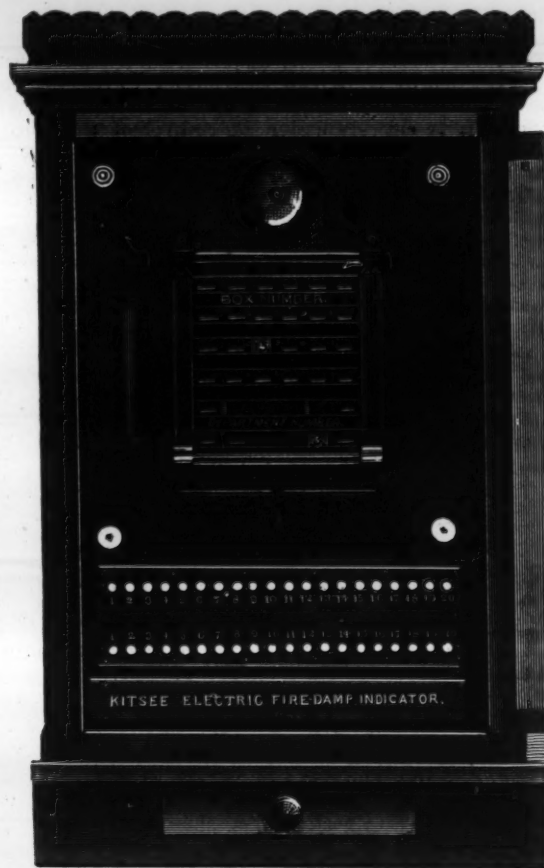


FIG. 4.

placement be somewhat different to the preceding; that instead of an individual box, a whole gallery is tested at once. In such a case the boxes in the gallery are placed upon one circuit, and the pressure of a button will at once serve for the whole section. The interior of the trough would, for such a purpose, be somewhat different to that shown in the figure.

When it is desired to test any box the official presses a button, or other suitable arrangement, in his office. A current is thereby sent along the wires creating a spark in all four compartments, and, if gas be present in any one of the four, an explosion ensues, causing a rise of temperature, and bringing the thermostat into action.

By this arrangement the circuit is closed, and the current traverses a return wire connected with a register in the office. A double signal, the first the number of the box and the second the number of the

compartment, is given; thus it gives indications upon a double register as represented by fig. 4.

It has been previously stated that the boxes are placed in a vertical position in hewn out receptacles in the wall of the gallery, but, as the gas is generally found close to the roof and in the seams and crevices of the same, an excavation is made in the roof, and into this the box is inserted as far as the floor of the topmost compartment. To further the flow of gas in this direction grooves or gutters are cut in the roof with an upward inclination, and converging towards the box, which, when tested, will immediately show whether the gas is, or is not, explosive.

In a mine equipped throughout in the manner just described, the officials in charge are in a position to be at all times informed as to the condition of the gas therein—its *locality, height, and explosiveness*. This knowledge should enable them to successfully combat against the occurrence of the terrible catastrophes with which the mining districts are so frequently visited.

We may in addition remark that the electric fire damp indicator will also notify whether combustion is going on in any portion of the pits, underground fires being not infrequent, and their development and breaking forth being often of slow growth. An announcement of a rise in temperature would offer a good reason for an investigation, the search being rendered the easier since the locality where it shall be made is electrically indicated above the surface.

The mine of the Moundville Coal Company to which we have already referred, is now fitted up with this system, and the superintendent, Mr. Wm. B. Brooks, states that from his knowledge and experience with the apparatus he is fully satisfied that it is of great value. Mr. Wm. B. Humphreys, the president of the company, also adds his testimony to the satisfactory working of the system since its introduction into the Moundville mine. The United States patents covering this invention are held by the Electrical Fire Damp Indicator Company, of New York, and a gentleman representing the European interests is now in London.

THE INVENTIONS EXHIBITION.

THE incongruity of lighting the electrical department of the Exhibition with lamps strongly recommended for their economical consumption of oil is about to be rectified by the substitution of a row of very handsome cut glass pendants of Osler's make enclosing 100 C.P. Swan lamps supplied through Gaulard-Gibbs secondary generators. The grand chandelier in the entrance vestibule, which made its first public appearance at the Crystal Palace Exhibition, has been taken away, and a new one substituted for it by Messrs. Verity Brothers. This is a very elaborate piece of workmanship in brass, the lights being arranged in two tiers, the upper one consisting of six groups of three lights, and the lower one of six groups of three lights alternating with six groups of five lights. Each of these lights consists of a 10 C.P. Swan lamp enclosed in a glass shade, in size, shape and surface, like a pineapple. There are also 12 lamps without shades round the base. Altogether there are 78 lamps of 10 C.P., and the effect is a wide-spread distribution of light free from all dazzle or glare, cool and pleasant to the eye.

(1297) Mr. Tayler Smith has now on view a good display of domestic electric light fittings in the shape of ornamental standards, pendants and brackets in wrought iron, brass and cut glass, suited to meet a great variety of requirements and tastes; a speciality being a combination in one of the table, the hanging and the wall lamp.

(1298) Messrs. Andrews and Co. exhibit a selection of apparatus illustrating the details of their electric light manufactures. Mr. Andrews, through a long and varied experience, has minutely studied the various points of a system of electric lighting, with a view to finding a simple and complete system of appurtenances, which might become as universally used as is now the system of gas lighting. As a starting point, Mr. Andrews decided that for a system to be general, the complications involved in arranging fittings for two wires, would be out of the question, and he therefore worked out the various appurtenances of his complete system for the one wire principle, whether applied to ships or buildings. He has arranged all fittings to be entirely independent of the wires that lead the current to them, so that they may be removed from their place of erection without in any way interfering with the wiring and the various parts of the fittings may be taken asunder, each part carrying its own piece of wire, which is a large practical size. Several varieties of these fittings are exhibited, consisting

of double-jointed brackets with switch in the fitting and safety fuse in the back block, electroliers, ship fittings of all kinds, switches with quick break, without springs, suitable for sinking in the wall or floor as a gas tap now is and safety fuses to suit, and switches of the same mechanical design arranged to fix on the face of the wall, &c. There are also a variety of fittings for the double wire system for cases of special necessity, as well as arc lamps and dynamos.

(1299) H. A. Fergusson here shows the Lalonde-Chaperon, or Lalonde-Spence or Spence-Fergusson primary battery. A set of 30 cells or dishes, stated to have been charged on the 30th of April, have since that time afforded current sufficient for the occasional lighting of four glow lamps, working a Griscom motor on a sewing machine, and similar services. The nature of the elements of the battery, the plates in various stages, the charging liquids, the residuals and other matters are also illustrated.

(1300) Messrs. J. Coxeter & Son exhibit a very complete collection of medical batteries, some of them possessing novel features, and various instruments for professional use. An interesting exhibit at this stand is the dwarf water-wheel dynamo, in which the force of the water of an ordinary high pressure domestic supply is utilised to revolve a small water-wheel enclosed in a tin drum, the shaft actuating a small dynamo. The current thus generated is sufficient for a small incandescent lamp, such as is required for dental and surgical examinations. The force of the water and speed of the dynamo is regulated in the most simple manner by means of an ordinary tap, and the arrangement appears to be a very handy one for professional purposes, and wherever the light is required occasionally at short notice and for brief periods.

An odd corner at this end of the arcade has been utilised in a pretty way by Messrs. Howard and Sons, of Berners Street. Domestic electric fittings, consisting of a chandelier and three or four brackets and pendants of novel if not eccentric design, forming the minor proportion of a miscellaneous display on a small scale of furniture, paper hangings, curtains, carpet, parquet flooring and other decorations.

(1304) A curious and elaborate piece of clock-work placed here is thus described in the catalogue:—"A continuous motion electric clock, striking the hours and quarters by electricity. The batteries for both going and striking will continue in action for two years."

(1305) To specimens of secondary batteries which do not make a very attractive show, the Electrical Power Storage Company add some interesting items, showing the purposes for which they are used, and others for which they ought to be used, notably the running of tramcars. The two Reckenzaun motors here shown, one of 1½ H.P. and the other 3 H.P., are specially adapted for the propulsion of launches and tramcars in conjunction with accumulators. The current from accumulators is exhibited lighting the lamps upon the stand, driving a lathe, and in connection with other curiosities, among which may be mentioned chicken hatching by electricity, Sellon's patent foot warmers, bed warmers and room warmers.

(1307) The School of Electrical Engineering have brought together a number of representative instruments used in connection with telegraphic operations, including Thomson's siphon recorder, Wheatstone's tape instrument and many others. Two items of interest are the apparatus used by C. F. Varley in his experiments with the first Atlantic cable, by means of which he determined its speed of signalling and dimensions; and the original apparatus exhibited by the same gentleman before the Royal Institution, showing the retardation of signals through a long submarine telegraph cable.

ELECTRIC LIGHTING IN THE CITY.

At the fortnightly meeting of the Commissioners of Sewers, on Tuesday,

Mr. J. V. MOORE moved, "That having regard to the repeated failures of private companies to supply electricity, it is desirable that the Commission do undertake street lighting by electricity, and that it be referred to the Streets Committee to select a small area, and to obtain estimates of cost of installation." He said, since 1882 the committees of the Court had been unceasingly engaged on the various references submitted to them relating to the electric light, and the result of all the investigations and correspondence might be stated in the one word, "failure"—absolute failure. At the present moment there was not one single electric lighting station in the City of London. He thought, as the lighting authorities, they ought to exercise the privileges and duties belonging to them, and endeavour to keep abreast of the improvements of the age. They ought to give to the City the best lighting they could on the best terms. Private firms were lighting with satisfaction and effect; the same thing was being done by hotels and railway companies, and he thought in the City they might use the electric light with equal satisfaction. He maintained that they already had sufficient power under their own Lighting Act. The wires of certain companies had not been disturbed, and it would be comparatively easy to carry out the scheme he proposed.

Mr. SHAW had wanted to see whether this was a serious resolution. He could not understand that any member of the Court would agree to such a proposal. The subject had been before com-

mittees for several years, and he did not think a scheme generally acknowledged to be a failure was a thing to be taken up by a public body dealing with the ratepayers' money. In every instance that this had been touched it had turned out a failure. Until it could be done on some commercial basis they had no right to entertain it at all. They knew that a certain few gentlemen had picked up large sums of money over the recent flash in the pan, and that the general public had lost to an extent almost unparalleled. Their friend had no practical knowledge on the subject, and if they agreed to go into the matter it would be very much against their credit for commercial prudence.

Mr. BOWING thought it a practical proposal, and one which deserved their best attention. It was an undeniable fact that electricity was being used very largely all over the country, and throughout Europe and the United States.

Mr. J. C. BELL thought it should go to the committee for re-investigation, as they might benefit by their recent failures. The enormous amount of promotion money paid by the companies had been the cause of their failure. He had found the electric light a great success in every large city in America.

Mr. Alderman LAWRENCE objected to the Commission being asked to assert that they would undertake to light the City by electricity, as invited to do in the resolution. He urged that it was premature to enter upon any such proposition. On the Thames Embankment the electric light had been removed by the Board of Works, and the same thing had taken place in Paris, showing that when the cost was taken into account, the electric light, as at present established, was found to be too expensive.

Mr. Deputy ASHBY was desirous of promoting the use of electricity, but at the same time they must remember the enormous cost of an installation that would be of any practical use in the City of London. He therefore moved, as an amendment, "That it be referred to the Streets Committee to consider and report whether it is desirable that the commission should undertake the supply of electricity, and that it be referred to the same committee to select a small area and obtain an estimate of the cost of installation, reporting thereon." He looked forward to the time when lighting would be included in the rates.

Mr. F. GREEN asked how far this amendment differed from a reference sent to the special committee some time since.

The CHAIRMAN: It is identical.

Mr. F. GREEN: Then what are we to gain by sending it to the Streets Committee?

The CHAIRMAN: It has not been submitted to this commission. It was last year.

Mr. F. GREEN thought that was a distinction without a difference.

Mr. Deputy BEDFORD regarded it as an extremely mild form of resolution. He invited members to go to theatres and large establishments where the electric light was in use. The present lighting of the City cost less than a penny in the pound, and they had an offer from a gentleman who lighted Holborn Viaduct to give double the light for a contemptible increase of £130,000 a year. They were so economical on the question of lighting, and so extravagant on other matters, that they refused to accept that offer.

Mr. SHAW pointed out that the expense of the electric light at the Savoy would stagger those who talked about it being used for purposes of ordinary lighting.

Mr. PANNELL thought the commission would some time or other have to try an experiment in a small way. Some small area should be selected and the contractor guaranteed against loss. The commission might then be able to arrive at the cost.

Mr. MOORE, in reply, quoted Mr. Preece as to the impossibility of working the light under the present Act. He ridiculed the idea of the enormous cost of the electric light, and contended that they might solve the problem at an expense of £1,500.

The amendment was agreed to.

IMPORTANT TELEPHONE PATENT CASE.

(Specially reported for the ELECTRICAL REVIEW.)

HIGH COURT OF JUSTICE.—CHANCERY DIVISION.

(Before MR. JUSTICE NORTH.)

UNITED TELEPHONE COMPANY, LIMITED, V. BASSANO AND SLATER.

The plaintiffs in this action sue, as the owners of the Edison patent of July 30th, 1877, for "improvements in instruments for controlling by sound the transmission of electric currents, and the reproduction of corresponding sounds at a distance," and they seek an injunction and damages against the defendants for an alleged infringement of that portion of the patent which forms the transmitting instrument. The plaintiffs' patent has been thrice amended by disclaimer, and has formed a frequent subject of legal proceedings, the most notable instance being the action of the plaintiffs against Messrs. Harrison, Cox-Walker, and Co., which is reported in ELECTRICAL REVIEW for May 6th, 1882, and following issues, and where, among other questions, the issue of infringement by other manufacturers was tried and decided in the plaintiffs' favour. The defendants in the present case were accused of infringing the Edison transmitter, by selling and advertising for sale telephones manufactured under letters patent granted in the year 1883 to themselves jointly with one Hollins,

The case came on for hearing on Monday last, when the Attorney-General, Mr. Aston, Q.C., Mr. Cozens-Hardy, Q.C., Mr. Moulton, Q.C., and Mr. Micklem were for the plaintiffs; and Mr. Bigham, Q.C., and Mr. Claude Plumtre appeared for the defendants.

The ATTORNEY-GENERAL briefly opened the case by stating that the questions in issue were the fact of infringement and the invalidity of the Edison patent for want of novelty. He then adverted to the leading historical features of a long course of discovery in telephonic engineering, and explained to the Court the Edison invention, and in what respects it was stated to be infringed by the defendants. He further stated that of the alleged anticipations of the Edison patent none was in fact relevant to be considered, except an instrument invented by a German named Reis, the description of which was published in 1862.

Sir FREDERICK BRAMWELL was then examined by Mr. ASTON, and stated that he had studied telephones from the beginning of their history. Edison said, in his specification dated 30th July, 1877, that "The vibrations of the atmosphere which result from the human voice, or from any musical instrument, or otherwise, are made to act in increasing or lessening the intimacy of contact between conducting surfaces placed in the circuit." I am reading the beginning of the provisional specification which is a general statement; he repeats it in his complete specification, but it is in a convenient form here. Edison turns to practical account what he has there stated in order to enable the human voice to be converted, as it were, into, and represented by, electrical currents, and cause the human voice to be repeated at distant stations.

Will you kindly explain how that is done?—That part of Edison's specification deals only with the transmitter, but for the purpose of the explanation how the voice can be, not conveyed, but reproduced at the distant station, it is, of course, necessary to have some idea of the receiver at that station. Edison describes that there shall be a current sent in by an ordinary electrical battery, that which he calls a tension regulator. The current goes along the line wire and at the receiving end is applied to a Bell receiver.

Will you kindly describe the complete circuit, if you please?—The Bell receiver has in it either a permanent or an electro-magnet, round about which there is wound a coil of insulated wire, which is in connection with the line wire. Very near to the pole of the magnet or to a prolongation of that pole, there is a thin metallic plate, which if, as is commonly the case, the magnet be a permanent magnet, is attracted towards the magnet to a certain extent. But if the electrical current passing through the coil can be caused to vary by some means, the strength of the attraction of this plate towards this magnet will also vary, and the plate will be set into vibration corresponding to the variations in the electrical current. Now if these variations in the electrical current could by some means be made a measure, as it were, of the variations in the waves of the air produced, we will say, by speaking, then the vibrations of the metallic plate at the receiving end should be and are competent to generate corresponding vibrations in the air which act on the ear and reproduce the sound, there having been no sound conveyed, but simply electrical variations of the current. The problem now is, how at the transmitting end to cause the voice of the speaker to produce the needful variation in the electric current. Edison effects it by placing in the circuit of the electric current that which he calls a tension regulator, a semi-conducting material which, being acted upon by the air waves set up by the voice, either comes into contact with similar material or with a metallic conductor, and the suggestion is that the extremely minute variations in pressure caused by the sound waves, make more or less surface contact.

Mr. JUSTICE NORTH: That is more or less surface contact in the materials of the regulator?—I presume in the materials of the regulator, but it seems perfectly incredible that anything can act in the way we all know it does. The variation of pressure must be so infinitely slight that one cannot see how it does act. But I was about to quote what the Attorney-General has already quoted from page 7 of the specification, where the patentee says (line 32, in the edition I have got): "As the tension regulator of fibre or of plumbago"—it will be found previously that he has spoken of compressed plumbago—"decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak."

Mr. ASTON: What is the greatest distance at which you have personally heard the apparatus speak?—I really do not remember; it was in America; I forget what it was—not many miles.

You know now, I believe, that it does speak between here and Brighton?—Yes.

Were not some experiments tried last week between Uxbridge and Liverpool?—I do not know; but as far as one has heard and read in America, they have not been tried much further than that.

Did you not see an account in the paper of the trial last week?—I have hardly read the paper for the last 10 days.

Have you read the various descriptions of all the modifications of tension regulators that are found in Edison's specification?—I have read the whole specification.

As far as you know with regard to each one, would they enable the tension regulator to be made as proposed by Mr. Edison?—Yes.

Mr. JUSTICE NORTH: Each of them is sufficient?—I believe so. I am speaking now entirely of this in connection with the circuit entirely closed.

Mr. ASTON: I call your attention to the fact that Mr. Edison in his specification describes at page 4, line 20, that he uses a resonant case. What is the meaning of a resonant case?—I presume that means a case for the apparatus competent to vibrate under the voice, under the air waves.

And resound?—And resound; such a thing as would, if you put a tuning fork upon it, set that tuning fork into vibration.

At page 4, line 53, Mr. Edison says: "By providing an edge in the resonant tube below the mouth upon which such consonant sounds will resound"—speaking of the "a"—"the vibrations are given either to the resonant tube or deflected to the diaphragm."

Calling your attention to those words "the vibrations," that means, I suppose, the vibrations caused by the vocal sounds?—The air vibrations due to the vocal sounds.

He says they may be given either to the resonant tube or deflected to the diaphragm?—Yes.

If they are given to the resonant tube, stopping there, and the resonant tube were put in communication with a tension regulator, what do you think would happen?—I think the tension regulator would perform its functions properly.

Those functions being what?—To cause variation in the electrical current traversing the line proportionate to the variation in the air waves caused by the voice.

Would you, if your recollection enables you to do so, take shortly three or four of the principal forms of tension regulator that Edison describes?—"I have shown several which will hereafter be named, but I find the most delicate to be small bunches or tufts, or discs of semi-conducting elastic fibre, such as particles of silk and an intermediate conducting or semi-conducting material; this device I call an electric tension regulator." Then on line 36 of the same page, he says how the silk is rendered semi-conducting. Then at page 6, line 4, he proposes to have "a disc covered with plumbago placed adjacent to a diaphragm also covered with plumbago, or other semi-conducting material, so that the proximity or extent of surface contact will produce rise and fall of tension." Then at line 31 of the same page, "In some instances I make use of the best quality of lamp-black, retained within a case to form the tension regulator, the circuit passing through the same, and the rise and fall of electric tension resulting from the compression of the same by the movement of the diaphragm." Then at page 7, line 15, "Those springs having points made of compressed plumbago, mixed preferably with gum rubber, but any substance not liable to rapid decomposition." Then, as I understand, this is parenthetical, "Or the elastic or fibrous tension regulator aforesaid may be used. These points face each other on opposite sides of the diaphragm, and make contact with platinum foil discs secured to the diaphragm."

What do you, as a mechanic, understand by diaphragm?—I prefer to take Lord Justice Fry's definition of it. I find the dictionary definition is something which separates, and has commonly got a hole in it. That is the definition in the dictionary I have.

Mr. JUSTICE NORTH: However, you adopt Lord Justice Fry's definition?—I adopt Lord Justice Fry's definition.

Mr. ASTON: Do you think it affects the operation, whether the voice speaks on one side or on the other of the diaphragm?—I do not.

It is a fact that the oscillations of the diaphragm may be taken, practically, at all events, at the beginning of motion to be the same in both directions?—I should think so.

At the top of page 10, line 3, Edison says, "In preparing the tension regulator, I find in some cases that it is preferable to use lamp-black, mixed with pure plumbago, amorphous, phosphorus, and a very small amount of non-conducting material, such as rubber dissolved in a solvent that will easily evaporate"?—Yes.

That is another form?—I see the marginal note I have made against that is "Query. Is not this a mere mode of coating his fibre in preparing the tension regulator?" Then at page 11, unless you tell me that is already struck out, is the other one acting on a series of springs.

What do you say, as a mechanic, as to tympan?—Again I say I adopt Lord Justice Fry's definition of it.

Now, having called your attention to that specification, would you be good enough to look at the instrument which I understand my learned friend Mr. Bigham admits to be like the one made and sold by his clients, the defendants. It is the very one, I believe.

May I ask whether you have seen that practically tried?—This is one like it.

Will you tell my lord what happened when you did try it?—When spoken to, treating it as a transmitter, there being at the other end of the line wire an ordinary Bell receiver, there was (I am obliged to say as I was informed) reproduction of articulate speaking at the receiver, and when I went to the receiver, and I was informed somebody spoke to it, I heard the articulate speech, but the difficulty is to perform this experiment and be at both ends of the line at once.

Mr. JUSTICE NORTH: You say that, having tried both ends in turn?—From having tried both ends in turn, Dr. Hopkinson carrying on the experiment in change with me. First he went to one end, and I to the other, and then we reversed it.

Did you recognise Dr. Hopkinson's voice?—I forget whether I did; I think I did, but I am not clear.

Mr. ASTON: Assuming that you have examined the construction of that, what do you say as to the parts of which it is composed?—I find a resonant mouth-piece, or a resonant case on a wooden diaphragm. On the side of the diaphragm towards the speaker, I find a tension regulator. Put the tympan in a vertical position, imagine that fixed against the wall, you speak down the tube.

What does the tension regulator consist of?—Two carbon pencils, the ends of which are thinned down, and lie in holes in carbon blocks.

As far as that action goes, comparing it with the Edison regulator, what do you say?—In my judgment it is substantially the same thing. The regulator itself is of the kind that Edison has indicated—carbon. The word "carbon" never occurs in Edison's specification, according to my recollection, from one end to the other, but lamp-black and plumbago do.

Are those forms of carbon?—Yes.

As far as the combination of tension regulator with diaphragm or tympan, directing your attention to that being the claim, do you find the combination the same or different in the apparatus before you?—It appears to me to be the same diaphragm or tympan, with the tension regulator in a closed circuit. I am aware that Edison in his figure 1, and generally, shows a diaphragm interposed between the voice and the tension regulator, but I do not believe it is a necessity of Edison's invention. Moreover, I have already called attention to the fact that in fig. 10 one of the regulators is on the same side of the diaphragm as that by which the speaker's voice arrives.

Did you test that instrument, or the defendants', in any way to ascertain whether it did make any difference if the diaphragm was interposed between the voice of the speaker and the tension regulator, or was on the other side?—Whether I spoke to the back of it, or spoke down the tube, the results were practically the same; but, if anything, speaking to the back was the better of the two, which I attribute not to the diaphragm being between the speaker and the tension regulator, but to the larger area operated upon by the voice. Still leaving the black part on the red, we then spoke to the side of this part. The result was not so good, although perfectly audible. We then removed the black part altogether from the red, and spoke into that. It spoke, but not nearly so well as when combined with the red. I should like to go back and give another reason for the better speaking when speaking to the back of the diaphragm, namely, that when you speak down the tube on to the tension regulator itself, there is a certain amount of jar, which appears to be removed when you speak to the back of it, when the breath does not act upon it. Then with the object of making sure that the voice set up vibrations in the back part—that resonant tube and box—we attached a string to it and conveyed it some yards across the courtyard, out of one window and into another, and put another trumpet of the same kind at the other end, and made a toy telephone of it. I spoke; you could hear what was being said.

After a short discussion as to the arrangements for the succeeding days of the hearing, the Court adjourned.

Tuesday, July 14th.

On resuming this morning, Sir FREDK. BRAMWELL was re-called, and further examined by Mr. ASTON. He said he had examined the particulars of objection as amended and delivered by the defendants, and had failed to discover in them any description of an instrument for transmitting electric impulses by sound, having a combination with a diaphragm or tympan of an electric tension regulator other than as described by Edison. The only thing bearing on the subject, as far as he could see, although it might have been relevant before the disclaimer, was not relevant now. He alluded to the Morgan-Brown provisional specification.

Mr. ASTON: As far as you know was it new on the 30th July, 1877, the date of Edison's patent, to use anything that was caused to vibrate by sound waves combined with an electric tension regulator in a closed circuit so as to constitute a telephonic transmitter?—Morgan-Brown proposed to make a variation by means of fluid, but I think it is specifically disclaimed in the sixth claim of Edison's patent. With that exception I do not find anything.

Cross-Examined by Mr. BIGHAM: The claims made by Mr. Edison were originally 33 in number?—I believe so.

And they are now reduced to this one?—Yes.

I want, Sir Frederick, to see that I understand as you understand, what the one is that is claimed. Does it comprise tension regulators of any kind?—I will read the words and endeavour to put my interpretation on them, if his lordship wishes.

That is what I ask you to do—I want to see if we agree. Do you read it as covering any claim at all to tension regulators, apart from anything else?

Mr. JUSTICE NORTH: As far as construction goes, it seems to me that tension regulator is governed by the words "substantially as hereinbefore described."

Mr. BIGHAM: Yes, my lord. But I should say that the whole thing is governed by the words "in combination with." But I want to see clearly as to the meaning of the claim.

Sir FREDERICK BRAMWELL: I really don't feel competent to say what is the legal meaning.

Mr. BIGHAM: I want to know what you understand—it may be right or it may be wrong—by the claim?—Sir Frederick, having read the words of the specification, commencing, "I would observe in conclusion, that I do not claim generally the transmission and reproduction of sound by increasing and decreasing the resistance of the circuit, &c." said: That, I presume—but it seems to me that my opinion is not worth anything—is a combination claimed, but how far under a combination claim, sub-combinations or separate parts are themselves claimable is a thing on which I dare not express an opinion.

I did not ask you to express an opinion, but what it is you understand.—That is what I call an opinion. My opinion is that

it is a claim of combination, which I know is not inconsistent with something else than a claim of the whole combination.

Do you mean to say this claim in your opinion entitles the plaintiff company to the exclusive use of tension regulators such as are described in this specification?

Mr. ASTON: Is not that really for your lordship?

Mr. JUSTICE NORTH: I think it is.

Mr. BIGHAM (to witness): You said, I think, that you were present at the Scottish trial, "United Telephone Company v. Maclean." Did you hear this question put by Lord McLaren: "I suppose if they (the defendants) dispensed with the diaphragm they would be without the patent, because the tension of the diaphragm is the material point?"—I don't remember such a question.

Mr. JUSTICE NORTH: Where is it reported?

Mr. BIGHAM: I have only a report of it in the ELECTRICAL REVIEW.

You don't remember the Lord Advocate, appearing for the telephone company, assenting to that proposition?—I do not.

Do you agree that if in the transmitters made by the defendants there is nothing in the nature of a diaphragm, there would be no infringement of the patent?—That appears to me to be a repetition of your previous question, as to my opinion.

Take the specification, and say what sort of diaphragm is contemplated by this specification. I am going to suggest that the diaphragm in this specification is something in the speaking tube, the tube itself, and I draw your attention to page 4, line 19. It is the part of the specification which the Attorney-General referred to yesterday as the key-note of the whole: "In my present invention I make use of the vibrations given to a diaphragm or tympan by speaking into a resonant case to produce a rise and fall of electrical tension upon the line," and so on. Reading those words, don't they convey to you the idea of a division or partition in the resonant case itself?—I do not know that they do. That is to say, they are not inconsistent with the diaphragm being at the extreme end of the resonant case, in which instance I should hardly call it a partition in the case.

Of course that answer is intended to cover what I call the base of the defendant's instrument?—I don't know what you call the base, but I mean that it is not a necessity that the diaphragm should be within the tube.

Refer to line 27: "The resonant tube or box," &c. Now, where does the resonant tube end, do you say?—I don't know that I could put a limit to it. I presume that the resonance ends with the end of the tube. In the instance you have shown me of the defendant's apparatus, I should say that the resonant tube ended at the smaller end of this conoidal tube, where it comes upon the larger black surface with which it is united.

Mr. JUSTICE NORTH: Before the base expands again?—Yes, my lord.

Mr. BIGHAM: In one of the plaintiffs' tubes (produced) where do you say the resonant case or tube ends?—I should say that the resonant tube there ends just about the diaphragm; nearer the mouth than the diaphragm.

Mr. JUSTICE NORTH: So that the diaphragm is not within the tube, in your view?—I do not think it is. It is quite clear that that part of it where the little hole, *x*, is found is described in terms by the patentee as the tube.

Mr. BIGHAM: Do you really mean to say that the diaphragm in the Edison transmitter is not, in your opinion, in the resonant tube?—No, I do not think it is contained within it; I think it is at the end of it.

"The resonant tube is adapted for being spoken into, the same having a diaphragm or diaphragms against which the sound waves act." I ask you, is not the diaphragm within the resonant tube?—Well, I should think not. It is not a necessity, and in the drawings not as a fact.

You agree, I hope, that the diaphragm, as contemplated in this specification, is totally distinct from the resonant case—a different thing altogether?—It is a different thing from the resonant tube; yes.

Is there not a base or support to which the Edison transmitter is ordinarily attached?—Commonly, not. But I am misleading you. I thought you meant as made according to the specification. You mean in practice? Most probably.

I mean a support or back to it, or base similar to that which is attached to the defendants' transmitter?—I do not know that it is similar to that. I do not know that the Edison telephone, as made in practice, is at all benefitted by that which supports it.

The transmitter that is generally used is a fixed thing?—Fixed to some extent.

Dealing still with the plaintiffs' diaphragm, is not its main object to produce compression in the tension regulator?—Yes. Its main object is to present an enlarged surface for the air waves, so as to act more efficiently to produce the pressure. I don't like to use the word compression.

Don't you think Mr. Edison contemplated compression of the mass?—In some part of his specification he certainly did. In some cases I don't know what he contemplated. I think he must have been very much puzzled himself as to why this thing acted.

Am I right in saying that the diaphragm contemplated in this specification is an instrument or thing which is always in contact with, and at times—that is to say, when the instrument is being used—producing an effect on the tension regulator?—That is certainly true of a great number of the things shown; but I am not quite clear that this is not an instance where the diaphragm is not actually in contact with it, but transmits its effect through something else.

Point out an instance in the specification where the diaphragm is not in contact.—I am not clear; it may be that I cannot. Fig. 9, I think, is an example, looking at the drawing. I may be wrong.

Mr. MOULTON: Fig. 12 is an instance where there is actually no contact.

Mr. BIGHAM: Is it not true that the object of the diaphragm is to produce actual compression or pressure upon the mass of the tension regulator?—Yes; either directly or indirectly.

Don't you call the cork part of the tension regulator?—No.

Then the cork is something that belongs neither to the diaphragm nor the regulator?—Something that comes between the two.

But there is in most instances no empty space intervening between the diaphragm and the tension regulator?—I think that is right.

Now, Sir Frederick, do you suggest that in this science the word diaphragm has a meaning different from or other than that which is attached to it in ordinary conversation?—I think an extended meaning is to be given. That is to say, I think it is clear here that the first object of the diaphragm is to receive the sound waves. You could well understand a diaphragm put across this Court having no such object.

I am not talking of the object it has to serve.—In this case it means the surface which is to receive sound waves, and make them more efficacious in acting on the tension regulator.

So you say that the resonant case was a diaphragm within the meaning of your definition?—I think one could very fairly say so. I believe the patentee intended the resonant case to be the first recipient of the sound waves to operate the diaphragm. I believe that the resonant case does play part of the functions of the diaphragm.

And you would scarcely call the resonant case a diaphragm in the ordinary parlance?—I would not.

I think yesterday you heard the definition of a diaphragm as given in the Harrison, Cox-Walker case?—Yes.

The definition given by Lord Justice Fry was a very wide one—"something which separated something from something else."—Instead of extending the ordinary signification I think I should say in telephony it has a more particular meaning.

Mr. JUSTICE NORTH: The wall of this court is something which separates something from something else.

Sir FREDERICK BRAMWELL: If it was to serve as a diaphragm for this purpose it would have to be so constructed as to act as a sounding board.

Mr. BIGHAM: What, as a matter of fact, was found to be the diaphragm in the case of Harrison, Cox-Walker?—The sheet of platinum foil against which the sound waves impinged, which lay upon the pounded coke forming the tension regulator, that diaphragm being in that case also the conductor on one side of the coke.

In that case did the diaphragm come into contact with the tension regulator?—Yes, producing pressure upon the tension regulator by means of sound waves, performing, in effect, the functions which Edison's diaphragm is intended to perform, with certain modifications of detail.

Had that instrument—the Hunnings instrument—a speaking tube?—I think there was a small tube in front of the diaphragm.

And the diaphragm there intervenes between the lips and the tension regulator?—Yes.

In the Hunnings instrument, is the diaphragm within the tube, or does it form the end of the tube?—I should say it is at the end of the tube.

Did you ever see a Hunnings instrument in operation?—Yes.

When in operation, was it supported by a board at the back?—No; when I saw it I don't recollect seeing any but the portable one used for the purposes of that action. I may have so seen it; but I don't at the present moment remember.

The diaphragm in this case separates one part of the instrument from another?—Yes.

As, indeed, the diaphragm in Edison's?—I should suppose so, in every case. I was thinking of fig. 10 for the moment, but I suppose in every case it separates something from something else.

Mr. JUSTICE NORTH: In Edison's instrument it comes between two parts of the same instrument?—Yes, I think so.

Mr. BIGHAM: Was it ever suggested during the enquiry before Mr. Justice Fry that any table or board on which it was fixed served the purpose of a diaphragm?—I think not.

Was it ever suggested, so far as you know, that the speaking tube acted as a diaphragm?—I don't know that the question arose. I don't think it did.

Will you tell me once more what it is in the defendants' instrument that corresponds with the diaphragm in Edison's specification?—In my judgment, when the instrument is attached to the mahogany board, supplemented by the enlargement which occurs at the termination of the resonant tube, that takes the place and performs the functions of the Edison diaphragm, by receiving the sound waves and transmitting them to the tension regulator. The tension regulator is fastened to this enlarged part in the defendants' instrument, and is within it. The addition of the red board adds to the effect of the transmission; and, as I have said, gives a better result when you speak at the back of the board than when you speak down the tube.

Mr. BIGHAM: Is the tube any part of the diaphragm?—I am not sure about that.

Is the resonant case?—Yes.

I should have thought it produced vibration in the same

manner as the lower part of the tube?—It may, and probably does, contribute to some extent.

You know, I suppose, that the resonant case has been disclaimed by Edison?—I don't know. I know he has only one claim left.

You say this larger part of the bottom in which the tension regulator is placed does perform the functions of a diaphragm?—Yes.

I may take it that any structure used to support tension regulators would perform the functions of a diaphragm?—No; you might have a structure which would not receive the sound waves, so as to render it of any value. I should say any substance which responded to the sound waves and transmitted them would answer the purpose of a diaphragm.

This bottom part, which you say performs the functions of a diaphragm, is not the diaphragm in the ordinary sense?—I answered that rather hastily. I think it is. It separates the air which is on one side of it, from the air which is on the other side.

In the ordinary sense of the word, as I hold up this sheet of paper, would you call it a diaphragm?—I should want to know the context. I should not go into a stationer's shop and ask for a diaphragm.

The mahogany back in the defendants' instrument, you also say, serves the purpose of a diaphragm?—Yes.

You have told us that if the tension regulators were held up by a string and the sound waves allowed to act upon them the result would be commercially useless?—That is my belief.

Do you mean to suggest that the sound waves would produce no effect upon the tension regulators?—No; that is why I introduced the word "commercially."

Without the aid of a diaphragm do you admit that some effect will be produced, and that sound might be transmitted?—I think it is extremely probable there might be some effect produced; that is why I restricted myself to its being a commercial effect. I have the strongest belief that if you were to take away from that implement the wooden portions of it the rest of the instrument would have no commercial value.

Put shortly, I suppose your contention comes to this, that inasmuch as the wooden portion discharges the functions of Edison's diaphragm the wooden portion does, in fact, form a diaphragm?—It constitutes a diaphragm.

As you define it?—In the telephonic sense of the word.

Do you really suggest that this black base, and the mahogany base, produce the effect upon the tension regulators?—Yes; in the same way, whatever that may be, as Edison intended the effect of pressure to be produced. I do not say how it operates.

Are those tension regulators employed by the defendants what are known as Hughes's microphones?—Yes; a microphone, not necessarily "Hughes's" microphone.

Hughes's microphone consists of hard pieces like carbon in loose contact?—Yes.

The current is regulated in this microphone by the alteration of the facets of the contact?—It may be.

Is it the generally accepted opinion that the current is regulated by the change of the facets?—I don't know. The small pressure, as far as I know, may increase the intimacy or the extent of the surface contact.

Supposing you have a number of loose pieces of carbon in a space, I suppose by pressure you can make the facets of the points of contact greater?—I think so. It would be increasing the extent of their contact.

Edison's tension regulators consist of a soft compressible mass?—Not always.

Will you show me in any part of the specification where it is not so composed?—I think I can; page 7, line 6:—"Having points made of compressed plumbago, mixed preferably with gum rubber, but any substance not liable to rapid decomposition . . . may be used." He distinguishes here between those regulators which are elastic and those which are not.

I suggest that compressibility is one of the essential features of all the tension regulators contemplated by Edison.—I think differently. I was asked a good many years ago, before the union of the telephone companies took place, by those possessing the Bell telephone patent, whether they could work certain carbon instruments because these microphones were not compressible, and urging that Edison's microphone was confined to what was compressible. I advised adversely, and thereupon the union of companies took place.

How do you describe hard carbon—as a good or bad conductor?—I think the term semi-conductor is a good term.

I suggest "good conductor."—As compared with a metal I think you are wrong.

I suppose what is good and what is bad is a question of degree?—A question of degree.

Re-examined by Mr. MOULTON: Your attention has been called to the passages in Lord Justice Fry's judgment:—"The quality which he required in his diaphragm is plainly expressed in the specification, namely, that it shall vibrate with the voice." Speaking as an expert do you think that is plainly expressed in the specification?—I think so.

The motion of the mahogany board would move these carbons would it not?—Yes.

Dr. JOHN HOPKINSON, examined by Mr. Moulton, said: I am a Fellow of the Royal Society, and practise as a consulting engineer. I have given special attention to electrical science for many years. I have read the specification of Edison's Patent No. 2909 of 1877, and have read, also, as part of it, the only claim

which now remains, which, in my opinion, fairly describes the inventions claimed by the patentee. The function of the diaphragm in this invention is to gather up the vibrations which exist in the air when sound is transmitted, and to apply those vibrations to the tension regulator, so as to vary the relation of its parts, and so cause variation in the resistance of the circuit. The defendants' instrument is an instrument for transmitting electrical impulses by sound. I find in that a diaphragm, the mahogany board at the back, and I also find that the mouth-piece itself is a diaphragm, that is, the tube and base. The patentee contemplates using more than one diaphragm in his patent as a variation. The strip of elastic foil over the hole is one diaphragm mounted upon another.

Mr. MOULTON having put in a drawing of a section of the defendant's instrument,

WITNESS: This appears to me to be an accurate section of the defendant's instrument. I have made experiments to determine whether the defendants' instrument is capable of taking up the vibrations of the voice. First, experiments were made using portions of the defendants' apparatus—the black wooden part—using that in the ordinary way as a lover's telephone, a string being stretched from the black base across a court yard, the string going to a little drum, forming an ordinary lover's telephone. We were able to carry on a conversation through it. The distance was, I should think, about 20 yards. That experiment proved, beyond all doubt, that when you spoke into the instrument the base portion of it was in acoustic vibration. That proved that that base was in a condition to act as a diaphragm. In the next case the thread, instead of being attached to the base, was tied round the conical part, and when attached to the lower part of the cone it answered well, but not quite so distinctly as when attached to the base. That proved that that portion of the cone was acting as a tympan or a diaphragm. Then we took the string up to the larger part of the cone. We found that the speech then was transmitted excellently; better than in the second case, as well as the first. That proved a similar conclusion. We replaced the black portion of the instrument on the red portion, put the whole instrument together again; then took the string from the red portion—the back of the instrument—to the lover's telephone at the other part of the building and tried it in the same way. We could hear exceedingly well. I was at the end where the defendants' instrument was placed, Sir Fredk. Bramwell at the other. I heard him distinctly. Very thick pieces of wood act excellently as a diaphragm. I have no doubt the panels of this room could be found to act as diaphragms. We then went on to try the instrument electrically, attaching it to an ordinary Bell telephone as a receiver. While we listened at the receiving telephone, and some one spoke into the tube, spoke against the side of the cone, and against the back of the mahogany board. In all three positions the speech was good. Broadly speaking, it made no great difference which position it was spoken to; but there were slight differences in the sound which enabled me, after hearing the three positions once, to tell which way the speaker was using the instrument. Speaking into the trumpet, the sound was loud, but at times the voice was a little thick, and the sound rasping. When the side of the cone was addressed the sound was clearer, but not quite so loud, and when the base-board was addressed from below the sound was both loud and clear. From these experiments I draw the conclusion that the base-board and the cone serve to gather up the vibrations from the air, from whatever direction these impinge upon them, and then affect the tension regulator attached to them so as to vary its resistance and transmit speech. That possesses all the essentials described in the specification. I next placed a cork at the lower portion of the cone, so as to stop it completely; the instrument spoke well. Then we tried another experiment, having a special cone prepared, which would shield the carbons from the action of the air. That also spoke perfectly well. Then we tried a cone like the defendants' cones, but with the carbons in the tension regulator slightly differently placed, so that the aerial wave would not impinge directly on entering upon the carbons. That spoke perfectly well. From that I draw the conclusion that, sensibly, the direct impact of the aerial vibrations upon the carbons themselves, has no part whatever in the effect produced. The hole in the diaphragm would not prevent it from acting as an acoustical diaphragm. In my opinion, the tension regulator in the defendants' instrument is such a one as described in the specification. Coke or carbon would possess sufficient resiliency for the purposes here. I do not understand the specification to confine tension regulators to what is compressible—that is sensibly compressible. I was present during the hearing of the Maclean case, and the instrument produced was the subject of that case. There were two carbon blocks in rigid connection with the diaphragm. I find, also, in the defendants' instrument, two carbon blocks in rigid connection with the black part of the instrument, and across these there are two loose pencils, similar to one in the Maclean instrument. I find no material difference in those instruments so far as relates to the matter of Edison's claims. In Maclean's instrument, the pressure was produced by the weight of brass; variations of pressure found their point of resistance through the inertia. In that case the cross pencil was of the same thickness all along, but it was weighted. The defendants' pencil was not weighted, but was thicker in the middle; this would have the same effect as the piece of brass in the Maclean instrument. That method of producing variations of pressure is contemplated by Edison in his specification. Acoustically, there is no difference between the tension regulator being on one side of the diaphragm and the other.

Cross-Examined by Mr. BIGHAM: I understand Edison to mean by a diaphragm any structure which communicates the vibrations caused by the sound waves to the tension regulator. I do not see that it matters what the form of the structure is, what its position, or what it is made of. I know the Reis transmitter. That was invented and used long prior to the Edison specification—was used for the transmission of sounds. The instrument produced appears to be fairly made according to such descriptions as I have seen of the instrument.

Mr. BIGHAM: You find there a mouth-piece, you find there a box, both of them capable of vibration when the sound waves of the voice strike on the surface of the box or mouth-piece?—Yes.

Would you say that that box and that mouth-piece represent Edison's diaphragm?—No doubt they do in a degree—if there were the other portions of Edison's instrument there.

Never mind the other parts. Do the mouth-piece and the box in the Reis transmitter represent what you would understand by an Edison diaphragm?—I don't quite understand what you mean by "represent."

The Edison diaphragm is a structure, as I understand it, which is put in vibration by the sound waves from the voice, and in that way affects the tension regulator?—Yes.

It does not matter, you say, what the shape of it is, what the material of it is, or what the position of it is?—Provided it acts in that way.

You define, in fact, the diaphragm by its effect, and not by its shape, form, or position?—In this connection, yes.

Do the box and tube in the Reis instrument produce the effect which, when produced, constitutes the producing instrument a diaphragm?—No; that I must explain.

Before you explain, I want to know whether in using the Reis instrument, the voice would produce vibration in the base of the tube and in the wooden box?—Yes, I think it would; but I have not tried it, understand.

Would that vibration produce any effect upon the current of electricity?—I doubt very much if that vibration would. I have little doubt that when spoken into all those parts would be in vibration, and if you attach to that box an Edison tension regulator, you would find that the box formed a sufficient diaphragm.

At all events, we have, very long anterior to Edison's patent, a construction which vibrates with the voice, and which was used in an instrument for transmission of sound?—Yes.

Now tell me, if you please, what was the first experiment you tried with the defendant's instrument?—In the first experiment tried the string was taken from the back base across the courtyard to a little drum on a lover's telephone. By talking to this black portion of the defendant's instrument we were able to hear sound transmitted from the lover's telephone. That was without the assistance of any electrical current at all.

I suppose that would have happened had you taken any two cones?—No, I don't think it would.

Taking the example given by the Attorney-General—two pill boxes?—Yes; but pill boxes are not cones. In the next experiment the string, instead of being attached to the black base, was tied round the small part of the cone, and the experiment was repeated in the same way. In the third the string was attached round the large end, with the same result as in the previous cases. The fourth experiment was with the red wood base board. The instrument was put together, and a string was taken from the base to the lover's telephone as before.

You heard more distinctly when the base board was tried than before?—No, I don't think so. In the fifth experiment, the instrument was put together in the usual manner and connected up. The experiment consisted of some one speaking to the transmitting instrument in three several directions; into the tube, against the tube, and at the back of the base, each of us severally listening at the Bell receiver. The third method was on the whole the best. The conclusion I draw from that is, that the way in which this operates as a transmitter is that the aerial waves are taken up by the wooden portion of the instrument.

You tried it, also, without the case?—The instrument was taken out of the base, some one spoke down. We did not hear very well. When we spoke into it we could hear well, but not so well as when it was in its ordinary position. We then took an ordinary thick book, and by placing it underneath the articulation was very much improved.

The conclusion you wish me to draw, I suppose, is that the mahogany base assists in forming what you call the diaphragm?—I have not the least doubt of it.

In this (defendant's) instrument you put the two carbon pencils away from the aperture, one on each side?—Yes.

Then you press the tube till the edge gets flush with the bottom of the speaking tube. Do you mean to tell us that that alteration produced no effect upon the result?—Yes.

And the conclusion you draw from that is, that the impact of the sound waves upon the tension regulators produces no effect whatever upon the electric current?—Direct, you mean? No sensible effect.

Would this instrument act as a diaphragm (handing up a leaden cone formed as a speaking tube)?—I don't think it would to a sensible extent.

Would you be surprised to hear that the instrument speaks, and speaks well, with a mouth-piece such as that?—That alone?

With a mouth-piece such as that.—It depends in a great measure upon what it is attached to. I should not expect it to speak well. I am not prepared to say it would not speak.

If it did speak at all, would it be in your opinion by reason of the vibration in the lead or the carbon pencils?—That I would not venture to say without experiment.

Supposing there were zinc or tin in the leaden cone, would that cause increased vibration?—I don't think there is any zinc there—tin possibly. The presence of tin would make it very much more likely to take up vibrations than without it. Antimony would have a similar effect.

That, I suppose, would depend upon the quantity?—A small quantity would have a sensible effect.

Would putty in a moist state form a diaphragm?—I don't think putty would be a suitable material.

Would it be a diaphragm? Would there be any vibration?—No; I don't think so. I don't think putty would act at all as a diaphragm.

Then, supposing, using that putty transmitter (put in), you found sound transmitted, to what action would you attribute the transmission of sound? I should attribute the transmission of sound, such as it might be, to the action of the sound waves upon the carbons themselves.

Then you agree that the direct impact of the sound waves upon the carbon pencils will produce an effect upon the electric current?—I think it is possible that it might. I have never seen it do so in the sense of transmitting speech.

I want to see whether you will admit that the direct impact of sound waves upon the carbon pencils will produce, not merely an effect, but a very sensible effect, upon the electric current?—As I have already said, I don't think that the effect would be sensible in comparison with the effects we get from these ordinary diaphragms.

Do you mean to say that the direct impact of the sound waves upon the carbon pencils does not produce, by itself, an appreciable effect upon the electric current—such as to transmit sounds, words?—Theoretically speaking, there would undoubtedly be an effect in that sense. I am not prepared to say, by carefully arranged apparatus in its other parts, you might not be able to perceive a faint sound. I have tried an experiment in which the tension regulator was taken out and suspended by strings. The result was that you could hear no articulate speech at all. But when spoken to exceedingly loud very close to it, you could hear a rattle.

A sound?—A sound; but not speech in any sense.

In the Scotch case, the case of the Maclean transmitter, what was alleged to be the transmitter?—As far as I recollect, a piece of cork and a piece of ferrotype iron attached to it.

In the Scotch case was it ever suggested that anything else constituted a diaphragm?—I don't remember that there was any such suggestion.

Was this transmitter (the Theiler or Maclean), when in operation, attached to any base corresponding to the mahogany base in the defendant's transmitter?—There was no base at that time, as far as I can remember.

I want to know whether there was not also some kind of wooden stand?—My own impression is that it was carried upon some form of wooden box.

During the Scotch case was it ever suggested that the cork or the mouthpiece constituted a diaphragm?—I don't recollect that it was.

Did you ever, till this case, hear it suggested that a mouth-piece and a stand constituted a diaphragm?—That a stand did, certainly—that a cigar box acted as a diaphragm. I have known that ever since Hughes's description of his microphone.

Have you ever heard it suggested, till this case, that a mere stand, upon which it is fixed for convenience, constitutes a diaphragm?—As far as I remember, I do not know a case in which the mouthpiece was considered to be substantially a diaphragm. But I do remember a stand being suggested as a diaphragm. I pointed that out myself in the case of Harrison, Cox-Walker.

You suggested then that the case or stand constituted a diaphragm?—I will tell you how it arose. To the best of my recollection, a putty transmitter was shown to me, placed upon a considerable piece of board, and I at once pointed out that that support constituted a very good diaphragm indeed, so that it is by no means now in this case that it is first suggested.

Do you remember, in the Scotch case, Lord M'Laren saying to the Lord Advocate, "I suppose if they dispensed with the diaphragm, they would be without the patent?" Did you hear any such question put, and the answer given "Yes?"—I do not remember.

Re-examined by Mr. MOULTON: Putty and lead are elastic within their limits, but those limits are narrow?—That is so.

Supposing two rooms are separated by a partition of sheet lead, would sounds be heard from one to the other?—Undoubtedly.

Does that show that sheet lead will take up vibrations?—Yes.

But is it most suitable?—No; wood is far better.

Would the fact that some sound was transmitted with a mouth-piece like that lead you to alter your opinion that the vibrations are conveyed by solid bodies to the tension regulators?—As I said before, I should wish to make careful experiments as to the way the effect was produced. I think the effect would be very small, but before I gave a decided opinion I should wish to try an experiment.

In Theiler's instrument, which part of it is the effective diaphragm?—Substantially, beyond all doubt, it is the cork with the piece of ferrotype iron upon it.

Sir WILLIAM THOMSON, who was next called, in examination by Mr. ASTON, said he had made himself acquainted with Mr. Edison's specification. So far as he knew, there were no tension regulators such as Edison used for telephonic purposes prior to the date of Edison's patent. Diaphragm was a correct term to apply to that part of his apparatus which operated to receive and to communicate the vibration set up in the air by vocal sound. It was in accordance with the meaning of the word and its derivation.

Mr. JUSTICE NORTH: Just tell me what you say is the meaning of the word "diaphragm"?—Essentially, according to its derivation, a divider—something that divides between—a separator. "Diaphragm" involves the idea of separating; and anything that does so, when separating is an essential to the functions considered, is properly then called a diaphragm.

When sound waves, created by the voice, impinge upon a surface and cause it to vibrate, what are the things that are separated by the vibrating medium?—The air on the two sides of the diaphragm.

And in order that the medium may vibrate and take up the sound-waves, must there be a separation of the air on one side from the air on the other?—Yes; there must be a sufficient separation to give rise to differences of air pressure upon the two sides.

Supposing there were no air on the side opposite to that which you speak to give way, the vibrations of the medium would be blocked, because there would be no means of allowing it to go to and fro?—There would be no force to cause it to go to and fro if there was no difference of pressure on the two sides.

Mr. Edison describes his resonant case in connection with a diaphragm?—Yes. He describes various substances that may be employed for his diaphragm. These are certainly not exhaustive. For the diaphragm, light solid substances, such as wood, paper, parchment, aluminum, mica, brass, iron, would answer best. Something exceedingly ill-suited for the purpose might be adopted to act effectively as a diaphragm.

Take, for instance, lead. Should you be surprised to hear that lead could answer?—Not at all. I would not believe it if I were told that it would not answer. Substances wholly or partially plastic in their character, such as water or mercury, could be used. I remember putty being in question when another action was tried in another court. I said then I believed it would act. It is a question of degree as to whether the material shall take up more or less readily the vibrations of the sound waves. For telephonic purposes, putty is nearly as bad a material as could be chosen. It is necessary for telephonic purposes to have as clear and as rapid a repetition of the sound-waves at the receiver end as possible, and also that the repetition be as true as possible, losing no feature of the variation of pressure of the sound-wave. Independently, some time ago, I made some experiments with the defendants' instrument at my laboratory in the University of Glasgow. I found it acted fairly well as a telephone transmitter when used in the manner for which it was intended. My attention having been called to an allegation made by the defendants that their instrument acted through the direct impact of the sound-waves upon the carbon pencils, with the view to testing the accuracy of this allegation I dismounted the carbon blocks from their position in the black cone, and fixed them to a small piece of wood, in order that there might be as little as possible of surface exposed to the air, besides the surface of the carbons themselves. I made the proper electric connections through thin wire soldered to the copper slips, which formed part of the instrument. The experiment was made between an upper and a lower room of my laboratory, a voice tube being used to facilitate the experiments. I myself was sometimes in one room, sometimes in the other. When I myself had spoken, with my mouth near the carbon pencils, I asked immediately after, through the voice tube, "Did you hear anything?" and the answer was, "Could distinguish nothing." I then shouted "Ah! ah! ah! Oh! oh! oh!" as loudly as I could. Then I asked, and the answer was, "A sound;" and something like it was given back to me through the voice tube. I then verified it by listening to the other end myself and instructed my assistants to read and to shout, and to make different sounds. I found a knock against the wires made a tremendous rattle. It put me in mind of the elephantine tramp of the fly in Hughes's celebrated experiment. I ascertained that it was impossible with these arrangements to hear the ordinary voice, to even so much as distinguish that the person at the other end was reading. But inarticulate sounds were heard, and, listening with great care myself, I came to the conclusion that when there was reading from a newspaper at the other end, the reason we did not hear it was that it was too faint. I believe that it would have been possible to hear the sound articulately if it had been loud enough. I believe, in short, that if I had increased the electric forces in the apparatus I might have made the sounds distinctly audible, and that then reading a book or speaking in an ordinary voice to the pencils thus supported, it would have made a successful telephone. My object was to test whether such mute, feeble, hypothetical action was the effect of action of the defendants' instrument. For that purpose I approached step by step to the actual conditions of the defendants' instrument. The first thing I did was to press a board against the little piece of stick on which the blocks were fixed; immediately at the other end ordinary speaking was heard quite distinctly. I moved the board, then no sound.

In your opinion would it be correct to call the sounding board a diaphragm in the sense in which Edison uses that word?—Perfectly correct.

At the time you applied the sounding board to the blocks was there any difference between the action of the sounding board as you used it and the mahogany base of the defendants' apparatus?—No substantial difference. I varied the experiment by pressing my little piece of stick sometimes against the one side of the defendants' board and sometimes against the other side, and got substantially the same results.

Then, did you in fact use as your sounding board that part of the defendants' apparatus which we have called the red back or red base?—I did.

When the blocks and carbon pencils were put in contact with that red back or base, you heard and heard well?—Yes; and when the block and pencils were disconnected from the red base, I heard badly. I replaced the blocks in their proper positions, and put in the carbon pencils, and re-made the instrument and put it in use according to the instructions of the defendants. I then found that it acted as a fairly good telephone transmitter. When I spoke to it in the normal manner, speaking into its own mouth-piece, if I did not speak too loud it worked well; too loud speaking caused it to jar, to give a mixture of articulate and inarticulate sounds. I have not the slightest doubt that that result came about through the breaking of contact between the ends of the pencils and the carbon blocks, so that the circuit ceased to be continuously a closed circuit.

Would that be caused by the direct action of the sound waves upon the pencils?—No, not in any way that I can see.

Why, then, when you spoke down the trumpet-shaped tube did you get this inarticulate sound now and then?—When I spoke in any direction I got that articulate sound if I spoke loud enough. Loud speaking would produce a less articulate sound when I spoke into the mouth of the instrument than when I spoke in other directions.

The Court then adjourned until Wednesday.

Wednesday, July 16th.

Mr. BIGHAM, this morning, before the resumption of the examination of Sir William Thomson, asked his Lordship's consent to an arrangement that the second action should stand over the vacation, upon terms of the defendants undertaking not to make, sell or use in the interval, the plaintiff's giving an undertaking to answer any damages for the interference with the defendants' business.

Mr. ASTON concurring in the application.

Mr. JUSTICE NORTH remarking that he did not understand that the application involved a postponement of his judgment in the first case, assented.

Sir WILLIAM THOMSON was then recalled and his examination continued by Mr. ASTON. He said to the best of his recollection he first heard of the use of putty in a telephone at the trial before Lord Justice Fry. Any substance, whatever, having sufficient conductivity to let a suitable current pass through it at a suitable E.M.F. might be interposed in a closed circuit, as proposed by Edison, to be used as a tension regulator. Silver and copper were the best materials. Iron had about six times the resistance of copper; bismuth about eighty times that of copper; and carbon about forty times that of bismuth, or some 3,000 times the resistance of copper.

Mr. ASTON: All those substances can be used as a tension regulator as described by Edison?—Yes.

Which are the best materials for tension regulators, good conductors or semi-conductors of low conductivity?—Semi-conductors are undoubtedly the most convenient; not of necessity the best in respect of the result, but most convenient for the purposes of commercial telephony.

As far as you know was the use of a tension regulator such as described by Edison in the manner and for the purposes indicated by Edison new at the date of his patent?—It was.

Cross-Examined by Mr. BIGHAM: Have you ever seen a transmitter constructed according to Mr. Edison's specification in actual use?—I have had in my own house and laboratory transmitters constructed according to Mr. Edison's specification, and have used them for many years.

Describe to me how the tension regulators in these transmitters are constructed—of what material?—A carbon button, I believe.

With any cover?—The particular form of the Edison tension regulator which I have in use is that known by the name of Blake.

Had the carbon button any cover?—To the best of my knowledge it is a carbon button pressed by a spring. I have not examined it very minutely, but I know the effect is produced by the pressure of what I believe is a carbon button against another conducting surface.

Tell me where, in the specification, you find that form of tension regulator described?—Fig. 10 is so nearly the same thing that I could not tell the difference, with one exception.

In the printed matter?—Page 7, line 13.

Take page 5, first of all. It is true, is it not, that the material which Edison supposed to be the best was small bunches or tufts or discs of semi-conducting elastic fibre, such as particles of silk, and any semi-conducting material?—I never understood that Edison considered that as the best. He described it as the most delicate, and is probably right in that description.

In point of fact, did you ever see in operation a transmitter with such a tension regulator?—Yes, I have. I have not seen it set up for practical use. I have understood it was found to be more true in its articulation, less liable to the microphonic jarring than the arrangement with the harder carbon.

Have you ever seen any such tension regulator in commercial use?—I saw at No. 6, Lombard Street, an instrument giving signals between that point and a place in the country about fifteen miles off—acting perfectly as a commercial instrument, with the exception that no payment was made. I saw it later in connection with the investigation before Mr. Justice Fry, and examined it. I have not seen any instrument in actual commercial use. I believe a great many such transmitters were made and sold. I lost an opportunity of seeing it in Glasgow in commercial use. I saw it afterwards in London.

Can you tell me at what date Edison discarded the fibrous tension regulators and adopted the hard carbon regulators?—I cannot tell you the date, nor can I tell you that he has discarded the softer button.

Do you know that, in point of fact, the Edison Company now manufactures no tension regulator of soft fibrous materials?—No, I do not know.

Can you tell me when it was you saw the transmitter with the fibrous tension regulator in it in operation in Edison's office?—I cannot tell the date, but it is easy to find it. It was before the amalgamation of the Bell and Edison interests. The Bell had at that time adopted the Blake. I had seen the Blake transmitter on the same day, in the Bell telephone office, and I felt so strongly that it was identical with the Edison that I urged my friends all I could to amalgamate. I saw them on the same day, and could not find any difference. If I had investigated minutely, no doubt I should have seen the difference. The transmitter handed to me is one that acts on an exactly similar principle to the Blake transmitter. It has the essentials of the Edison tension regulator. It is my impression that it is a Blake transmitter, but I am not sure.

Is this tension regulator the kind of tension regulator which the plaintiffs now use?—It is. It is the kind which I use in my own laboratory, under the Edison patent.

I am assuming that this transmitter is different from that which is mentioned in the specification, and if my assumption is right the plaintiff company are not using the Edison tension regulators?—I would answer that I consider it virtually the same instrument.

That is not my question. Assuming this Blake transmitter as constructed differently from the Edison specification, the plaintiff company is now using a transmitter which is not that described in the specification? It follows, you know, it is only an argument.

MR. JUSTICE NORTH: I am not quite sure it does follow. They might use something that was not described in it, and yet not different from it.

MR. BIGHAM: I meant something which does not come within the description.

SIR WILLIAM THOMSON: That comes within the description, most entirely.

The Blake transmitter was the subject matter of a patent?—I believe it was.

Assuming that this is a Blake transmitter, this instrument was itself the subject of a patent?—The subject of a patent which could only be used with the Edison patent—an improvement on Edison's, if it is admitted to be an improvement.

Where is the diaphragm in this Blake transmitter? I suggest that it is the brass plate.—It is the brass plate.

Would a diamond act as a tension regulator?—Its conductivity is not high enough.

Diamond is one of the very purest forms of carbon, is it not?—Yes, and crystallised.

Therefore, Edison, in this specification did not contemplate all forms of carbons—he clearly did not contemplate a diamond?—No.

I will take you to Fig. 10, page 6, lines 13 to 18 of the specification. Are these the words you rely upon as covering the hard carbon button?—I rely partly upon these words, and partly on some other words—the words "compressed plumbago mixed preferably with gum rubber." The description of semi-conducting material covers the whole.

What is the next best conductor to carbon?—I don't know. Moist wood is perhaps the next most practical known; but it is very far behind carbon.

Is there not a great gap between carbon and the next conductor that you know of?—A very great gap.

Cross-Examination continued by Mr. PLUMPTRE: Am I right in saying that plaintiff's diaphragm upon his tension regulator is to act by what is known as pressure?—Changes of pressure.

Is there no difference between what you call pressure and compression?—Compression is a resultant effect of pressure.

Then you have heard the words "acting by pressure"?—Yes, but I have no objection to add that that variation of pressure does produce variation of compression.

Is the word pressure used in the specification of Edison?—I have not noticed that it is. No doubt it is.

Is not the action in the defendants' transmitter what is known as microphonic?—I do not know what is understood by the term.

Does that not mean a variation of resistance caused by the variability of contact?—It does not. Loose contact in which a very slight shock is sufficient to break contact altogether, is the essence of the microphone. The softer the carbon contact is, the less is the instrument liable to the injurious microphonic action.

In the plaintiff's transmitter, in which the tension regulator is made of a fibrous material, would not that be an example of where the variability is caused by pressure or compression?—Yes.

Have you heard of an experiment by Prof. Hughes in which he

succeeded in varying the current which passed through three or four nails placed in loose contact, by merely speaking upon the nails?—Yes; I have seen the experiment.

Would not that be an example of varying the current by contact, as distinguished from the case I just put to you, of varying by compression where the materials of the tension regulator were fibrous matter?—No; that is a case altogether of variation of resistance by increasing or diminishing the intimacy of contact.

I think I understood you to say that a resonant mouth-piece is a diaphragm?—I did not say so; but it is so. Also the black base of the tube and the red back.

So I am right in saying that in this instrument there are no less than three diaphragms?—All in one. Three parts together acting as one diaphragm.

I suppose in all instruments conveying speech, whether by means of an India rubber tube or by a lover's telephone, or by more complicated telephones, there would always be something to collect sound waves, to speak into?—Not necessarily. Flat surfaces would speak.

In ordinary practice is it not always so?—Not always. A resonant case, as often used, is not essential—is often liable to introduce want of clearness.

Can you tell me of any telephone used commercially which has not something to take the place of a resonant case?—The Blake transmitter, for instance; there is no resonant case. There is a little cup to it, but not a resonant cup. There is no cavity enough to make a note of its own.

In point of fact, the resonant case is not claimed in Edison's claim?—I believe not. It is mentioned somewhere, but not in the remaining claim.

Is your definition of a diaphragm anything that vibrates?—A separator capable of vibrating, quite independent of form and of what it separates; but in telephone matters it naturally divides air.

So you would call something which separates space from space, a diaphragm?—Yes.

So that if I hold up a sheet of paper, you would call that a diaphragm?—Manifestly. I would call my hand a diaphragm if used with a lover's telephone, and it is effective in that connection.

And this wall, separating this room from some place outside, would you call that a diaphragm?—Yes. But I would rather say that this wood panelling is a diaphragm, separating the air in the court from the air between the wood and the wall.

Take a telescope tube; in the centre of that there is usually, I think, a disc with a little hole in it. Is not that, according to telescopic science, or the science of optics, termed a diaphragm?—It is.

Now, the physiological use of the term. That portion which divides the chest from the abdomen is called a diaphragm, is it not?—Yes.

Now, take the circular shell of the body, would you call that a diaphragm?—Possibly so; a diaphragm with a hole in it.

The circumference of the body—would you call that a diaphragm?—Only as it divides the external air from the inner portion of the body.

You never heard it called a diaphragm?—No. In one sense, perhaps, the chest and the lung cavity into which the air is taken—the separator—might be called a diaphragm. In osculation with a stethoscope, it is virtually used as a diaphragm.

Do not all, or nearly all, telephone instruments rest upon something?—I believe so. Nearly all, but not all.

Did you hear the question put by Lord McLaren in the Scotch case, as to dispensing with the diaphragm placing without the patent?—If it was said whilst I was in court I must have heard it, but I do not recollect it.

Re-Examined by Mr. ASTON: Assuming that one of the panels to which your attention has been called were fitted up in the following way: A tension regulator affixed to it by screws or otherwise, the tension regulator put into a closed circuit, are you able to tell my lord whether, in your opinion, the panel would act as a diaphragm and cause telephonic communication to be made?—It would; I am certain of it without experiment.

Under these circumstances, would it act as a diaphragm in the sense in which Edison proposes to use diaphragms?—It would.

You were asked whether a heap of nails put together, connected in a closed circuit, and rested on a board, would act as a tension regulator. What function would the board perform in that case? The function of a diaphragm. If a heap of nails were put on a very large solid mass of metal, such, for instance, as an anvil, the effect would be very much smaller than what I heard when I saw Prof. Hughes's experiment.

Speaking with scientific accuracy, are you able to say that even an anvil would be inert to vibrations of sound?—It would not be inert.

MR. JUSTICE NORTH: Or a large mass of putty?—Or a large mass of putty; but to a much smaller degree than if put in a cigar box.

MR. ASTON: I suppose you have read the descriptions of all the forms of tension regulator that Edison describes in his specification?—I have.

I won't put it to you whether they are all in commercial use, but are you able to tell me whether, in your opinion, they are all practically useful?—They are all practically useful, in my opinion. Practically useful in this sense, that any one of them could be made into a commercial instrument if there was prohibition against using any others.

In Edison's provisional specification he says: "The contact points or surfaces are sometimes metallic, but plumbago or similar semi-conducting material, into which the tympan or diaphragm is brought more or less intimately into contact, or a point or a pin thereon, serve to lessen or increase the electricity passing at that point." Now, is not that a general description of the materials that may be employed, and the mode in which they are to be used?—It is; and I forgot, I am sorry to say, this passage altogether in giving one of my answers in cross-examination. I wish to be allowed to add it.

Having called your attention to the fact that in connection with plumbago and lamp-black and other forms of carbon, Mr. Edison has so often referred to semi-conducting material, would you consider that such a hard form of carbon—and especially having regard to its crystallised condition—as the diamond was intended to be implied by Edison?—No.

MR. JUSTICE NORTH: Why not, Sir William?—Because of its want of conducting power; it could not be called semi-conducting.

You were asked as to various degrees of conductivity of different substances, and you were asked what came next after carbon. Carbon itself varies very much indeed, doesn't it?—Yes.

Taking such a thing as a diamond, has that a great deal of conductivity as compared with wet wood?—Enormously less than wet wood. Diamond is very different to all other kinds of carbon. Wet wood is far behind every form of carbon excepting diamond.

A series of experiments was here carried out with the various instruments produced in the case, treated in the different manners described, his Lordship testing the comparative efficiency of the respective exhibits. Upon their conclusion,

MR. JOHN IMRAY, C.E., and patent agent, was called. He said he understood the combination claimed by Edison to be a combination of a diaphragm or tympan—that was to say, something which, by obstructing waves of sound, would vibrate in accordance with that sound—with an electric tension regulator—that was to say, an imperfect-conducting body which, when acted upon by the diaphragm or tympan, gave variation of electrical resistance to a current passing through it. He understood by a diaphragm anything that would vibrate in accord with sound pulses. It necessarily must obstruct these pulses, and therefore separate what was on one side from what was on the other. He scarcely knew of anything which would not act as a diaphragm or tympan, more or less; some things were better than others, a thin piece of straight-grained wood being the best material. An electric tension regulator was an apparatus put into a circuit, and by introducing more or less resistance, caused a variation in the amount of current passing through the circuit. The diaphragm substantially described by Edison was a diaphragm or tympan substantially consisting of a plate or disc. The pulses of sound obstructed by it caused it to vibrate, and to communicate those small movements which constituted vibration to an electric tension regulator. If the tension regulator were placed between the voice and the diaphragm, instead of the diaphragm being between the voice and the tension regulator, the only effect would be to invert the movements. The tension regulator caused a variation of resistance, either by pressure, by a difference of intimacy of contact, or from a different density produced by compression of the substance used. These three classes, pressure, surface contact, and compression, were described in Edison's specification. With a tuft of fibre, the principal effect would be due to compression; with a plumbago coating, intimacy of contact; and with lamp-black, the result would probably be due to pressure. But he did not think those could in any way be disentangled. He took part in the experiments spoken to by Sir Frederick Bramwell and Dr. Hopkinson, and agreed with what they said.

Cross-Examined by MR. PLUMPTRE: Edison's specification included tension regulators made up of hard carbon. The word carbon was not used. He agreed with the statement of Lord Justice Fry, that the three characteristics of the tension regulator were compressibility, semi-conductivity and elasticity. Hard carbon was compressible to a sensible extent. He had never measured the extent of its compressibility, but he knew that it was compressible, for when he dropped it on the ground it rebounded.

The ATTORNEY-GENERAL intimated that this closed the plaintiffs' case.

MR. BIGHAM, in opening the case for the defendants, said: There appear to me to be three questions in this case, a decision upon any one of which in favour of the defendants will be sufficient to dispose of the action. The first question for your Lordship to decide is whether the defendants have infringed the plaintiffs' patent by using a diaphragm within the meaning of the specification; the next, whether they have used that diaphragm in combination with Edison's tension regulators such as are contemplated or described in the specification; and the third, whether the tension regulators contemplated by the specification are useful in a commercial sense so as to render the patent good so far as it relates to that. Now, my Lord, let me deal with the first question, which I admit at once appears to me to be an important question in the case—whether there is anything in the defendants' apparatus which can be fairly described as the diaphragm, contemplated by the Edison specification. I take it to be admitted, common ground, that there is nothing in the defendants' apparatus which could be described by the word diaphragm if that word were used in its ordinary, colloquial sense. There is nothing in the nature of a partition or division separating one part of the instrument from another; and, unless your Lordship has recourse to what Sir Frederick Bramwell called a telephonic interpreta-

tion of the word diaphragm, it is impossible to find in the defendants' apparatus anything which, by any ingenuity, can be twisted into a diaphragm. Now, what is it the plaintiffs say? I take the evidence of Dr. Hopkinson. I understand the plaintiffs say that Edison did not contemplate any particular form or shape or position, or anything of that kind when he was speaking of a diaphragm; all he contemplated was some physical effect, and Dr. Hopkinson, I think, said, if you have in connection with the instrument anything at all which produces the effect of the diaphragm as described by Edison in his specification, then you get a diaphragm in its telephonic sense, or I suppose in its Edisonian sense. Now, my Lord, I did not know, until two or three days ago, that a diaphragm had a telephonic or Edisonian sense. I knew that it had a sense in ordinary language, and I invite your Lordship to say that, unless you have very good reason indeed for doing it, you should not, in considering this specification, depart very far from the ordinary sense given to the words. Now, it is suggested that Lord Justice Fry, in his judgment, did depart from the ordinary colloquial sense of the word diaphragm and gave to it a sense which comes within the definition which the plaintiffs would now put upon the expression. I submit that Lord Justice Fry did nothing of the kind. Lord Justice Fry said, "I think the word diaphragm must be used in its ordinary sense. But (he said) I am sure that Mr. Edison contemplated, when he used the word diaphragm, a diaphragm which was capable of answering to vibrations caused by sound waves from the voice." Lord Justice Fry did not say that if there is anything in the machine which vibrates with the voice that will be a diaphragm; but he did say—get the diaphragm that Edison contemplated and it must be a diaphragm which will vibrate with the voice. After allusions to passages in Lord Justice Fry's judgment, Mr. Bigham said: Why I dwell upon these words is this—Lord Justice Fry says, I submit, in the plainest terms, the diaphragm must be taken in its ordinary sense, something separating something from something else. But it is obvious, and he says so, because of the interchangeable use of the words diaphragm and tympan, that Edison contemplated a peculiar property in his diaphragm, this property of vibration. Therefore, said Lord Justice Fry, if you (the defendants) use a thing which comes within the ordinary definition of the word diaphragm, and if it is found that the diaphragm vibrates with the voice, then you have got the thing contemplated by Edison, and you are infringing his patent. Now, my Lord, it is precisely that which the defendants have not got, and the plaintiffs are driven then to say, diaphragm must receive a telephonic interpretation. In this action before Lord Justice Fry, I am not aware that it was suggested that it needed to have a telephonic interpretation to distinguish it. I am not aware that it was suggested in the Scotch case; and it was not necessary. But now, in the pinch of this case, the plaintiffs find that there is no diaphragm at all; then they come forward and say, "We can dismiss the word diaphragm altogether. Diaphragm is not necessary if we find anything at all in the construction of your instrument which vibrates with the sound-waves of the voice; then we find that something which produces an effect which our diaphragm produces, and therefore it is a diaphragm." This is a question not capable of very much argument: it is a question of fact for your lordship whether the box, the base, and the wooden support, and the mahogany back—whether they could, by any twisting of language, be described as a diaphragm. If this theory of the plaintiffs is carried to its logical conclusion, everything is a tympan or diaphragm. You cannot have a thing constructed which is not a diaphragm, because it vibrates with the voice. But I will deal with a passage of the specification which clearly appears to contemplate the diaphragm being within or in connection with—Sir Frederick Bramwell suggested it might be at the end, but I don't think that matters—the speaking tube itself. Certainly in every case delineated in these drawings the diaphragm is something which stretches across the tube. In no part of the specification or drawings is anything referred to as a diaphragm or tympan which does not correspond with this brass plate in the plaintiff's own transmitter.

MR. JUSTICE NORTH: But, Mr. Bigham, he speaks of "diaphragm or diaphragms."

MR. BIGHAM: So it has been pointed out, my lord; there is one instance where the plural is used. But if you refer to the *b* in Fig. 1 you will find that the reference is to the diaphragm—the one diaphragm, a division stretching across in front of the tension regulator, and I think I am right in saying that in no case, either in the letterpress or in the drawings, is anything referred to which does not correspond with what we ordinarily understand as a diaphragm. And when you look at the claim at the end of this specification your lordship will see that what he claims is a combination in the instrument for transmitting electric impulses by a sound, a combination of a diaphragm or tympan with a tension regulator. Therefore I don't think there is very much comfort to be derived by my friends from the fact that on page 4 the plural is in one case used together with the singular. Your lordship had a model of the Hunning's transmitter produced, and your lordship will see there exactly what the diaphragm was. It was a piece of platinum foil placed as you would expect a diaphragm to be placed in exactly the same position as the diaphragm in nearly every instance shown in Edison's drawings and in his specification. That is to say, it is a diaphragm placed in front of the tension regulator, and a diaphragm upon which the sound-waves coming from the voice act directly from the voice; that is to say, the lips and the diaphragm are in a direct line. The whole of Lord Justice Fry's judgment must be read with reference to the subject matter of it, and regard must be had to the construction of that instrument,

when you are to ascertain what the Lord Justice meant. Therefore in that matter he said: Here is a diaphragm, something which I understand to be a diaphragm in its ordinary sense. It is a diaphragm which performs the functions which I believe Edison intended that his diaphragm should perform, namely, that of vibrating with the voice; and therefore it comes within the meaning of the specification; and therefore the defendants in that action failed. In that action there was never a suggestion that the box, mouthpiece, or anything of the kind, acted as a diaphragm and constituted an infringement. Going to the Scotch case again, there was something which answered to an ordinary notion of a diaphragm. The ferrotype iron, with the cork at the back forms what we understand as the diaphragm. The only question in both these cases was, was the diaphragm corresponding with the diaphragm described in Edison's patent? But what your lordship is asked to do in this case is to say that, although admittedly there is no diaphragm of any kind in the ordinary sense of the word, still there is something which produces the effect which a diaphragm might be expected to produce, and therefore it is an infringement of the patent. Before I leave this part of the subject let me say that we propose, if it is necessary that it should be done, to show by experiment that the red mahogany back, or base, does not, as it has been suggested, improve the operation of this instrument at all. It has been suggested, as I understand, that the mouth-piece operates also in the same way. Now, my lord, I took a mouth-piece which I called lead, and which I can prove, I think, is lead, and I also put a lump of putty into Dr. Hopkinson's hands; and I think we shall be able to satisfy your lordship that materials of that kind, capable at all events of a theoretical vibration, do not improve the sound. Whenever Edison describes any other part, such as the resonant case, it is always described as something totally different from the diaphragm. There is not a suggestion in the specification, in the judgments, or in the two cases that these things, which are now strained out of their ordinary meaning, in order to make them appear to be diaphragms, were diaphragms. We never heard such a thing until Sir Fredk. Bramwell came and told us that there was a telephonic sense in which the word diaphragm was used. As to the tension regulator: our tension regulators are, as I submit, not compressible within the meaning of Edison's specification at all. They are hard carbon regulators, and they are made of a material which, I submit, contrary, of course, to the contention of the plaintiffs' witnesses, was not contemplated by Edison in his specification. It is suggested that he contemplated all kinds of carbon.

MR. JUSTICE NORTH: Most kinds of carbon.

MR. BIGHAM: Well, my lord, it was at one time suggested that he contemplated all kinds of carbon, until it was discovered that all kinds of carbon was going too far. Then it was said: "No; it does not include a non-conducting kind." We find two kinds of carbon mentioned, lamp black and plumbago, and in every case, as I submit, the carbon is used in such a way, and in conjunction with such substances, as to make a compressible mass—something capable of compression. And that seems to be one of the essential elements of these tension regulators as described in Edison's specification. I shall be able to satisfy your lordship that, as Sir Wm. Thomson said this morning, pure carbon, such as we use for our pencils, is not a semi-conductor in the ordinary sense of the word, but a good conductor, a well-known distinction, and I think I shall be able to satisfy you that there is in the hard carbon pencils not that compressibility that Edison's specification contemplated.

MR. JUSTICE NORTH: Then, if that is so, how do you get the variation of current?

MR. BIGHAM: I don't profess to be able to explain that scientifically. Scientific witnesses hesitate themselves to say, I believe. I suggest this myself, that it is not produced in the hard carbon pencils by compression, but by some alteration of the facets presented by the pencil against the socket, producing a result similar to that which Edison gets by compressing his mass; but how or why the effect is produced I am sure I don't know.

MR. JUSTICE NORTH: You say that the pencils get altered in form?

MR. BIGHAM: The sound waves from the voice cause, I suppose, some sort of tremor.

MR. JUSTICE NORTH: Tremor means if you have a bottle full of fragments in a state of tremor, they must be moving, each must at one moment be nearer to its neighbours than at another. Then there is pressure. The only way in which I see the pencils can be altered is by one touch in making the contact.

MR. BIGHAM: That is what I suppose does take place with our tension regulators—moving about, rattling in the socket. But that, I say, is something very different from compression of such fibrous matters as silk mixed with carbon—such as is never used. I understand, but such as is described in the specification. It would be wrong to say of a carbon pencil shaking about in a socket that it is subjected to compression. It may, and, of course, does, in shaking about in the socket, present different facets of its surface to the face or hole of the socket; but there is nothing of the nature of compressibility such as Edison contemplated when he was describing these tension regulators, made of plumbago mixed with gum or some sort of soft substance of that kind, or when he was describing fibre mixed with plumbago, or when he was describing how these springs should be adjusted so that this sort of motion should go on. Sir William Thomson was asked by me, I think, whether he had ever seen an Edison transmitter constructed in accordance with this specification in actual use. He said he had—one, he thought, in the Edison office,

although he was not quite sure, nor could he tell the date. But I think he admitted that they were not in commercial use. I should like my friends, if they can, to show us a transmitter constructed according to their specification, in actual use here, in order that we may see whether it works at all. If it is necessary to go into that part of the case at all, I shall be able to satisfy your lordship that a combination of a tympanum or diaphragm with such a tension regulator as that described is a valueless combination altogether. These are, shortly, the facts. I shall call before you evidence of the same class as that which has been placed before you by the plaintiffs. I repeat, I think the main question is, aye or no, is there a diaphragm—a diaphragm within the meaning of the specification? and I appeal to your lordship to use your own common sense and judgment upon an exceedingly small question, and answer the question, can the things which they assert form a diaphragm, by any twisting of words or twisting of sense, be called a diaphragm?

The Court then adjourned until Thursday.

NOTES.

The Electric Light in the Chinese Navy.—A few days since three ironclads, which have been built for the Chinese Government at Stettin, arrived in Plymouth Sound, and considerable interest attached to their visit, seeing that they cost about a million and a half sterling. The turret ship, *Chin Yuen*, which is a vessel of 7,800 tons, is fitted with one large electric light in the forepart of the ship of 40,000 candle-power. The *Ting Yuen* is a sister ship to the *Chin Yuen*, and is fitted the same in every respect. The other vessel, the *Tae Yuen*, is of 3,200 tons, built of steel, and not armour clad. One mast is fitted with the electric light.

The Leeds Coliseum Lighting.—This building, the near completion of which was signalled by the visit of the Prince of Wales a few days since, is well provided with the electric light. The contractors are Messrs. Cordner, Allen & Co., Limited, London. The system adopted is a combination of incandescent and arc lamps. The motive power is supplied by a 25-horse (nominal) engine, and boiler, made by Messrs. Davey, Paxman & Co., Colchester, and the dynamos are of the latest type, constructed by Messrs. Mather and Platt, Manchester. For the lighting of the body of the hall seven arc lamps are used. These are suspended from the roof—three down the centre and two on each side. Eighteen incandescent lamps are placed in each of the two semi-circles forming the dress circle and the amphitheatre. In front of the panels at the back of the saloon or ground floor and in the dress circle are 48 of these lamps. Each light is enclosed in a large opaque grape-shaped globe, which depends from ornamental brass brackets. The vestibule is lighted by a fire-light electrolier or chandelier and two double wall brackets, incandescent lamps being employed. The passages, retiring-rooms and refreshment-rooms are lighted throughout with incandescent lamps. The installation is so arranged that every other lamp is on an alternate circuit, and in the case of the failure of one of the two dynamos, the lamps on one circuit will supply ample illumination for all practical purposes.

Electric Lighting on the "Exmouth."—On Tuesday the Clerk to the City of London Union placed on the table the minutes of the Metropolitan Asylums Board for June 5th, 1885, and called attention to a letter from the Local Government Board, dated June 19th, "consenting to the managers entering into a contract with Messrs. Davy, Paxman & Co., of Colchester, to supply the necessary boiler and engine power for warming the baths and driving the dynamos for electric lighting, &c., at the training ship *Exmouth*, for the sum of £590, without requiring sealed tenders to be sent in." Mr. Tattersall asked Mr. Dwarber how much electric lighting had cost up to the present time, and how much more it was likely to cost. Mr. Dwarber replied that he was so disgusted with the whole matter of electric lighting that he had declined to give any information, even when he was in a position to do so.

Electric Light at the Mansion House.—Mr. George Offor, of the Consolidated Electric Company, writes as follows to the *City Press* of Wednesday:—"Another failure of the electric light at the Mansion House" is calculated to prejudice the public, unless it is explained that such failures can be absolutely prevented by the use of storage batteries, without which no system of incandescence lighting is perfect. All installations of importance are now being made with the aid of storage batteries. Among those successfully working in the City, I need only refer to the Bank of England, Peninsular and Oriental Steam Navigation Company, Messrs. F. Huth & Co., Messrs. A. Gibbs & Sons, Messrs. Spink and Son, Messrs. Foster & Braithwaite, Messrs. Johnson, Matthey & Co., the Falstaff Restaurant, the Consolidated Electric Company's offices and factory. This company tendered to light the Mansion House with 520 lamps of 20 candle power, entirely from storage batteries, but I presume that the General Purposes Committee, in giving the contract to the Hammond Company for their system of direct running, were actuated solely by an apparent economy, sacrificing the most important element of thorough efficiency. In so important a public building as the Mansion House, the first consideration should be to obtain a light that can be depended upon for not going out just when most needed, and an artistic arrangement of the lamps is also very essential. When the Mansion House was first lighted it was with wretched arc lamps, in the style of a railway station or iron foundry, and the present display is far from suitable to the civic palace."

Temporary Electric Lighting.—At an "At Home" given by Mr. Thos. Cordes, M.P., at Hill Street, Berkely Square, on the 9th inst., Messrs. A. R. Sennett and Co. temporarily installed the electric light, upwards of 100 lamps being employed.

The Electric Lighting Act.—Mr. Warton in the House of Commons, asked the Secretary to the Board of Trade whether the Government intended to take into consideration the question of amending the Electric Lighting Act, 1882. Baron H. De Worms said it was not intended to deal with the matter this session.

The Electric Light, &c., in Russia.—The Municipal Administration of Moscow is at present engaged upon the question of establishing an installation in the city, with the object of lighting and transmitting power therein.

Electric Light in Collieries.—As a consequence of the recent disastrous explosion in the Clifton Colliery, we, *Mechanical World*, are glad to note that voices have already been raised from more quarters than one to advocate the use of electricity in lighting our coal pits generally, and those in particular which are dangerous to life and limb, by reason of an excess either of gas or floating dust particles. Practically speaking, all these explosions, of what kind and amount soever, are due to the presence of a bare or partly exposed flame in the explosive mixture or atmosphere; and the sole remedy against such frightful outbursts as have so often occurred is to enclose every part of the miners' lights, so that there may be no possible chance at any time or under any circumstances of even a spark being given out. This end is partly gained by the well-known safety lamps, which, however, by no means always deserve their name, and only obtain their good quality at the expense of much of their light. On both these points the use of electric glow lights is by far to be preferred to that of oil lamps, in any shape, since the former can be made to give any desired amount of light, and is, in addition, perfectly safe when due care has been exercised in its installation. When it can be used as cheaply as are the present class of lamps there should be no doubt or hesitation in its general adoption throughout our collieries.

Ship Lighting.—We note that Messrs. Weedon and Irish have secured an order for the electric lighting of the steamship *Algoma*, the last vessel launched by Messrs. J. L. Thompson and Sons.

Theatre Lighting.—The electric light at the Prince's Theatre has now been extended to the stage, but is used there only in the third act of the "Great Pink Pearl."

A Telephone Rating Appeal.—Messrs. C. Godwin and J. F. Fry have given their decision in a most important appeal by the Bristol and South Wales District Telephone Company against the rating of their property by the Incorporation of the Poor. Before the decision of the magistrates was read Mr. Fry said that there were many novel points in the case, to which they had consequently given a great deal of time and consideration. Their decision was to the effect that they were of opinion that the ratable value of the property to be assessed was not affected by the royalty payable to the Postmaster-General, such payment being analogous to ground rent, or, perhaps, more in the nature of a license enhancing the value of the undertaking, as in the case of a license for the sale of intoxicating liquor improving the value of the premises to which such license is attached. With regard to the annual sum paid to the United Telephone Company for the telephone instruments—which they considered purely personal chattels, and as such not ratable—such sum included the actual cost of making the instruments, as well as a charge for the patentee's remuneration for the privilege of using them. Therefore the Bench held that the appellants should be allowed to deduct such a sum as would be equivalent to the interest which they would have been allowed as a deduction had capital been invested in the purchase of the instruments. So far as they had been able to ascertain from the materials before them they thought that £2,000 would be a fair sum to represent the cost of acquiring such instruments as the absolute property of the appellant company. There would be allowed 5 per cent., as if on borrowed capital, and 10 per cent. to represent tenants on the following items: working capital (which they now estimated at £1,000, so as to make the deduction of 15 per cent., £150 the sum arranged during the argument) £1,000: present rate of batteries, £1,000; estimated value of telephones, £2,000; total £4,000, thereby making at 15 per cent. a deduction of £600 off the gross receipts. They considered that a large sum should be deducted from what had been termed "reproduction," as it had been shown that the wires rapidly deteriorated in some parts of the city and required frequent renewal. They fixed that item at £790, or about 10 per cent. of the present cost of wires and batteries, and about 5 per cent. of the cost of the poles. The result of these figures would be as follows:—Gross rental, or receipts, £4,425; less management expenses, &c., £1,936, leaving £2,489, as to which figure the contending parties did not differ. Then deduct, say, 10 per cent. for wires and batteries, and 5 per cent. on poles, £790; rates and taxes (not including income tax), £337; interest, at 5 per cent. and 10 per cent. to represent tenant's profit, on working capital, present value of batteries and estimated value of instruments, £600; which reduces the total to £862, applying which figures to the earnings in the district for which the respondents are the rating authorities and the district of the appellant company's working (which is alleged to be in the proportion of 82 to 100, or .82) they should be able to apportion the ratable value by calculation, and taking that of the "ancient city" at .82 it would amount to about £707. Consequently their decision was that the ratable value must be reduced from £1,538 to £707 per annum.

The Reduction of Telephone Rates.—A deputation of subscribers to the Lancashire and Cheshire Telephone Company, Limited, waited upon the directors of the company in Manchester last week for the purpose of urging upon them the necessity for a reduction in the

exchange rental rate. The deputation was received by Mr. C. Moseley, chairman of the directors, who referred to the prices paid for exchange connections at Dundee, Newcastle-on-Tyne and Hull, and argued that although his company could not lower their rates so far as the local company in Dundee, which was in a very advantageous position, owing to its use of instruments on which no royalty had to be paid, still as regarded the other towns named the rates in Manchester were not really higher. His company had always had before them the importance of rendering their service as popular as possible by reducing the rates to the very lowest point; but the directors did not feel that they could make any further reduction. At the same time, they recognised the importance of meeting the difficulty in some way, if practicable, and they had at the present time under consideration what they might term a new multiple subscription system, by means of which a number of gentlemen might be on the same wire, and yet be able to actuate from their own office the absolute control of the single wire. Before they laid this before the public they were desirous of making a fair test of it, and, if the result was what at present it promised to be, they might be able to see their way, by actual reduction in the cost of manipulation, to offer under certain conditions a reduced rate to subscribers. Under existing arrangements, however, it was not possible to reduce the rate below £20.

The Telephone in Devonshire.—Active canvassing is being carried on in Torquay with the view of opening a telephone exchange. The results so far are said to be encouraging, and it is expected by the representatives of the Western Counties Telephone Company that an exchange in the charming Devonshire sea-side resort will soon be an accomplished fact.

Telephonic.—Last week National Telephone workmen were busily engaged erecting a line for the Greenock Water Trust from the Municipal Buildings to Overtown and Loch Thow, to replace the one presently worked with A.B.C. apparatus, and maintained by the Post Office. The Greenock Foundry Company has discarded the A.B.C., and adapted the telephone. The principal firms in Greenock have now telephone facilities.

Long Distance Telephony.—On Saturday, the 27th June, the Telephone Company of Egypt, by permission of the Eastern Telegraph Company, had a trial of long distance speaking instruments between Cairo and Alexandria, a distance of 135 miles. The result was in the words of the manager, Mr. Evans, "Very satisfactory, far surpassing any previous trials; the magneto bell rang well between the two places, and the speaking was clear and distinct." The instruments used were a pair of the Consolidated Telephone Construction and Maintenance Company's long distance speaking transmitters, with magneto combination and bell receiver, sent out by that company specially for trial in Egypt.

Cheap Telegrams.—The *Economist* cannot understand the position which Lord John Manners has taken up with regard to cheap telegrams. Parliament has decided that a reduction in the rates for telegrams shall be made on the 1st of August next, and in order that its resolution might be carried into effect, it voted the expenditure of half a million of money. This money has been spent, and the late Postmaster-General was prepared to reduce the rates on the date appointed. Now, however, that Lord John Manners has assumed the direction of the department, he wishes to deny the public the advantage for which they have paid. He does not like that portion of Mr. Shaw-Lefevre's scheme which proposes to charge for addresses, and he is apparently unable to formulate any alternative proposal.

Greenock Telegraphic Facilities.—The annual report of the Greenock Chamber of Commerce and Manufactures, submitted last week, contained the following paragraphs:—

"**Telegraphic Facilities.**—Your directors have continued to urge the Post Office Department to provide additional outlets for Greenock telegraphic business, and a deputation, consisting of your Chairman, Mr. Sutherland, M.P., Mr. C. H. Curtis, and Mr. Robert Kerr, had an interview with Mr. Patey, the Secretary of the Telegraphic Department of the General Post Office, in February last, and pressed the views of the Chamber. Mr. Sutherland has since been in communication with Mr. Patey, but your directors regret to state that the Department have intimated that they do not see their way to provide an additional outlet for Greenock in the meantime, on the ground that the business will not justify the outlay. A complete return, showing the extent of the Greenock telegraphic business passing through the Glasgow Post Office, has been promised by the Department; and after this return has been received your directors will be better able to deal with the question. The attention of your directors has been called to the charge made by the Greenock Post Office for delivering telegrams at the east end of the town. This, with other postal and telegraphic questions, is receiving attention.

"**Sixpenny Telegrams.**—A Bill to provide for the introduction of sixpenny telegrams was some time ago introduced into the House of Commons by Mr. Shaw-Lefevre, the late Postmaster-General. Your directors, while approving of the main objects of the Bill, did not agree with the proposal to do away entirely with the system of free addresses, and they have therefore petitioned the House to retain the system of free addresses in a modified form. They further wrote to Mr. Lefevre, suggesting that five words in the address might be allowed to pass free of charge, and they also urged that the fee of £1 ls. charged for the registration of telegraphic addresses should be considerably reduced; another point referred to in your directors' communication has been satisfactorily disposed of, the Post Office Department having announced that in the case of inland telegrams, figures, not exceeding five in number would in future be counted as one word, and that the names of towns, although composed of more than one word, would also be allowed to pass as one word."

Sixpenny Telegrams.—At a meeting of the Glasgow Chamber of Commerce on Monday, Mr. Stephen Mason said he wished the directors to consider the propriety of drawing the attention of the new Government to the fact that they would be much disappointed if the Sixpenny Telegram Bill was not passed into law during the present session of Parliament. There was no contentious matter in the Bill, except that Lord John Manners, as representing a portion of his own party, contended for free addresses. Mr. Mitchell had no doubt of the utility of the measure, but he doubted whether it would be wise to approach the Government after the distinct statement that they were not going to proceed with the Bill. Mr. Mason said Lord John Manners had qualified the statement in his original speech, by saying that the Bill was still before Parliament. If adequate pressure were brought to bear on the Government the measure might yet be passed. Mr. Anthony Hannay, Mr. James Campbell, and Mr. McLaren seconded the proposal of Mr. Mason, and ultimately it was agreed to transmit to the Government a copy of the memorial sent to the late Government.

Forgery of a Telegram.—Lilian Roberts, the Leeds schoolgirl who was arrested on a charge of forging a telegram from the Chief Constable of Leeds authorising the release of a man arrested in Austria, has been discharged from custody. The girl's mother, who knew the man, wrote out the telegram, which was acted upon by the Austrian police, and their prisoner has not yet been recaptured.

The International Telegraph Conference.—A telegram from Rio Janeiro announces that Senhor Capanema has left for London, on his way to Berlin, where he will represent Brazil at the International Telegraph Conference, which will meet on August 10th.

A New Telegraphic Signal Station.—A Lloyd's signal station is about to be established at Anaga Point, on the Island of Teneriffe. The station will be in telegraphic communication with this country by means of the cable recently laid connecting Teneriffe with Cadiz.

The Telegraph Acts Amendment Bill.—The Committee on the Telegraph Acts Amendment Bill, prepared by the late Government, has been postponed until Monday next.

A New Cable.—The laying of a new telegraph cable between Aberdeen and the Shetland Islands was completed on Tuesday by the cable ship *Monarch*. The cable will be of great value in the development of the herring fishing industry, in which fast steamers are now employed.

Cable Data.—The article to which Messrs. Siemens Bros., in our correspondence columns, refer, was originally published in the *Electrical Engineer*, as stated by us at the time of its appearance in our pages.

Electrically Illuminated War Balloons.—A series of experiments to show the practicability of flashing war signals at night by means of an electrically illuminated balloon, the invention of Eric S. Bruce, Esq., M.A., Oxon., will commence next Monday evening at the Albert Palace, under the personal superintendence of the inventor, who, after giving a short lecture, accompanied by interesting explanatory experiments in the concert room of the building, will, by the aid of a captive balloon of some four thousand feet capacity, show the utility of his invention in the grounds. The balloon will ascend to an altitude of five hundred feet, and on a clear night should be visible fifteen or twenty miles away. Mr. Bruce's invention has excited much interest among the military authorities, many of whom will be present at the initial ascent.

Scientific Evidence.—Probably one out-come of the telephonic litigation now going on in London will be the true meaning of the word "diaphragm," as embodied in the Edison specification. Since the existence of the telephone, the definition of the thing which divides something from something else has been much like the movable *do* in the *tonic sol fa* system, very shifty.

Business Extensions.—The Kinetic Engineering Company has removed from Brooke Street, Holborn, to more convenient premises at 89, St. Martin's Lane.

Mr. H. Thorpe, of 59, Theobald's Road, has found it necessary to take premises at 34, Eagle Street, Red Lion Square, as a manufactory, continuing his office and warehouse, however, at the old address.

Lightning Conductors.—At the last monthly meeting of the Glasgow Architectural Association, a paper on "Lightning Conductors" was read by Mr. James A. Walker (of Messrs. Wm. Bryden and Son). Copper as the material of the "tape" or "ribbon" section, having overlap and riveted joints rather than the butt ends enclosed in a mass of solder, was preferred by the author. Insulation he condemned, and its continuance at Government powder works a thing to be wondered at. Considering the low cost of their application, lightning conductors were, Mr. Walker thought, too sparingly employed; when employed, however, the necessity of periodical testing was insisted upon.

The Lancashire Maxim-Weston Electric Company, Limited.—The liquidators of the affairs of this company in a circular say that: "Having now got in sufficient of the assets of the company to enable us to pay a dividend of 3s. in the pound to the creditors, we beg to give you notice that such dividend is now payable." Also they say that "they hope shortly to be able to pay a small further dividend and to wind up the liquidation." This result is certainly a wretched one for the creditors, and a detailed statement of the whole financial history of this company would, we think, be very interesting. Admiral Inglefield having been a director of both this and the parent company, would probably be in the best position for the task. By the way, is it a fact that this gentleman and another of the directors claimed from the liquidators 300 guineas each for attendances?

Meardi's Ampèremeter.—The mercurial ampèremeter of M. P. Meardi has been anticipated by a much simpler arrangement invented by Mr. Millar of the Gérard Company, in which an iron core floating on mercury produces a displacement of coloured liquid in a tube, the whole being in one straight line.

The Distribution of Electrical Energy.—Messrs. Paris and Scott, of Norwich, have now in practical operation a system of electrical distribution. Their converter has an armature wound for high tension and low tension, and has, of course, two commutators. The high tension current drives the armature, the low tension side giving off the lighting current. By this means they are lighting some flour mills, where 45—50 volt. 20 C.P. lamps are fitted, the conductor between dynamo and converter being of No. 14 B.W.G. phosphor bronze wire; the distance the wire runs is about a mile. An eminent electrician is, we understand, about making measurements and tests as to the efficiency of the system. It is evident, however, that the loss in transformation must be much higher than that occasioned in the method adopted by Gaulard and Gibbs, and, in addition to this, the scheme has been before proposed if not actually carried out to a practical issue.

The Electrical Transmission of Power.—The dynamo machines intended for the next experiments at Creil are constructed by Messrs. Mignon and Rouart, and the bobbins by the firm of Breguet. M. Marcel Deprez was too sanguine in his first experiments with dynamos of the Gramme type. Will he be more fortunate in this fresh attempt? We would greatly desire to believe so, but the general impression is that we are now looking upon a retreat in good order. Furthermore, we begin to know what to think of this supposed industrial revolution which electrical transmission of power should bring us. The example of the hydraulic establishments at Bellegarde will suffice to put us on our guard against dangerous illusions. There we have had, for the past 30 years, a hydraulic power of 10,000 H.P., which still waits development; at present there is 1,900 H.P. disposable, of which less than half has been utilised. They have not dared to erect the turbines for another 1,900 H.P., and for the 6,200 remaining they have not even constructed the buildings necessary for their utilisation. Who would give more for electricity? We do not see, and we have no reason to suppose that the experimenters of Creil can succeed better than the creators of the establishments at Bellegarde.—*Bulletin Inter. des Telephones.*

The United Telephone Company v. Bassano.—Our report of this trial, which is now proceeding, will be perused with avidity by those of our readers who are in any way interested in telephonic matters. The matter at issue differs in several respects from the points involved in previous suits.

The Applications of Electricity.—We would call particular attention to the article, in our present issue, dealing with an application of electricity to mining purposes for the prevention of explosions.

Fatalities from Lightning Strokes.—During the past 50 years it is said that 2,500 persons have been annually struck by lightning in France, the fatalities amounting to four per cent. as a yearly average.

Electrical Engineering at University College.—The Council of this College have instituted a Professorship of Electrical Engineering and have appointed Dr. J. A. Fleming thereto. Dr. J. A. Fleming retains his connection as advising electrician with the Edison and Swan Electric Light Company. Courses of lectures and demonstrations will commence in October.

Electrically Propelled Cars.—Thomas A. Edison and Stephen D. Field have pooled their patents on appliances for electric motors. According to our trans-Atlantic namesake, Mr. Field said, recently: "Within two months the electric motors will be as complete a success on the elevated railroad in New York as horse cars are on Broadway. We are now laying rails for electricity between the tracks of the Second Avenue Elevated Railroad from Chatham Square to Harlem, and if we cannot run over the whole line, I am willing to acknowledge the thing a failure. Our trial proved that not half enough has been claimed for the electric motor. All electricians who have seen the motor work declare the problem solved, so far as the electrical part is concerned." We suppose that after the electrical propulsion of passenger cars has been successfully established in America for a few years, capitalists will be found in this country to pluck up enough courage to do something of a practical nature at home. Unfortunately, the English nation is generally behind others in the development of anything new and startling.

NEW COMPANY REGISTERED.

Electrical Navigation Company, Limited.—Capital £40,000, in £1 shares. Objects: To adopt an agreement of 3rd inst. between Anthony Reckenzaun and Edgar Fairweather, relating to the sale and purchase of certain patent rights for inventions and electro-motors, or dynamo and electrical machines for propulsion of marine and other vessels. Signatories: J. W. Weight, 2, Copthall Buildings, 10 shares; F. Hicks, 2, Cornwall Terrace, Regent's Park, 100 shares; Admiral Sir George King, K.C.B., 1, Halkin Street, West, S.W., 50 shares; G. N. Duck, Royal Thames Yacht Club, 50 shares; T. Lloyd, 40, Hogarth Road, South Kensington, 1 share; W. Agnew Pope, Bolton Gardens, South Kensington, 50 shares; Gustav Binswanger (electrician), 29, Aldermanbury, 50 shares. The signatories are to appoint the first directors, and are empowered to act as directors *ad interim*. Qualification: 50 shares. Until otherwise determined by the company in general meeting, the remuneration of the board will be £250 per annum, and a further sum equal to 10 per cent. of the surplus net profits remaining after payment of 7 per cent. per annum dividend. Registered 13th inst. by Messrs. Alsop, Mann & Co., 23, Great Marlborough Street, W. Registered office, 6, Arthur Street East, London Bridge, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Anglo-Continental Telephone Company, Limited.—At an extraordinary general meeting of the shareholders in this company, held on the 11th ult. at the offices of Messrs. Fox and Greig, 22, Austin Friars, it was resolved to wind up voluntarily, and Mr. James Gordon Greig was appointed liquidator. The shareholders also approved the resolution of the board of

directors for the distribution among the debenture holders and creditors of the company of the shares of the "Societa Telefonica dell'Italia Centrale," with the dividend now payable thereon, received by the company from Mr. Charles Cheston, in pursuance of his agreement with the company. These resolutions were confirmed on the 2nd inst., and filed 11th inst.

Telephone Company of Austria, Limited.—An agreement dated 6th inst. (filed on the 10th inst.), provides for the issue of 10 fully paid shares to each of certain subscribers of £100 in the 5 per cent. mortgage debenture bonds of the company.

Railway and Domestic Electric Lighting Company, Limited.—The registered office of this company, formerly at 28, York Street, Westminster, is now situated at 6, Great St. Helen's, E.C.

Anglo-American Brush Electric Light Corporation, Limited.—An agreement, dated 7th July, provides for the allotment of fully paid shares in pursuance of three agreements, dated respectively 28th November, 28th November, and 29th November. The agreement is between the company of the first part, the Great Western Company of the second part, the liquidators of the Great Western of the third part, the Brush Midland Company of the fourth part, and the liquidator of the Midland of the fifth part.

CITY NOTES, REPORTS, MEETINGS, &c.

The Eastern Telegraph Company.

Mr. JOHN PENDER, M.P., presided on Thursday, at the 26th half-yearly ordinary general meeting of this company, at Cannon Street Hotel.

Mr. Geo. Draper, secretary, having read the notice convening the meeting, and also the minutes of the previous meeting, The Chairman said: Gentlemen, you have had the report for some time before you, and I presume you will take it as read? Before moving the resolution for the adoption of the report, I shall make a few remarks, as I generally do on these occasions, although the report gives you so many details. The revenue for the six months ending March 31st, 1885, amounted to £371,682 against £345,156 in the corresponding period of last year. The increase was no doubt owing to the large number of Press and Government telegrams sent in consequence of the military operations going on in Egypt, China and other places. The total working expenses amounted to £291,599 against £290,482 in the corresponding period of 1884, an increase of £1,117. The principal items showing the increase and decrease were:—£1,085 decrease in London; an increase of the working expenses of stations of £2,959; and the details of the increase occur under the head of salaries and wages at the stations, and other matters. During the last six months four new stations have been opened—at Perim, Patras, Piræus and Katocolo. There is also a full six months' charge for the working of the Souakim station against only four months in the same period of 1884. The repairs and renewals of furniture, &c., at the stations show an increase of £961. We have been obliged to take larger offices at Gibraltar, where we have a very fine office now. We make Gibraltar to some extent a station for perfecting our young operators in the work which they are required to perform at the different stations in the Levant or in the far East, if necessary. There are also several other amounts in connection with the different stations which make up the expenditure I have named; among them "repairs to stations," principally in connection with Gibraltar. Medical attendance shows an increase of £54; and then there was an increase for rations, &c., at Souakim, where food during the war was very scarce, and it was absolutely necessary that our young people, if they were to perform the extra work required of them, in a proper manner, should be well fed and kept in a good state of bodily health. In these days of electricity, we have taken advantage of the inventions, and have introduced the electric light into our station in London. That has cost £362; but we find that where headwork is so absolutely necessary, as in our operations, that it is desirable in small rooms that we should have the air kept as clear and pure as possible; and we are able to work more efficiently with the electric light than by gas. We lose no opportunity of making the surroundings of those who carry on our work as healthy as possible. On the other hand, there were some decreases; amongst them rent, fuel, and light, £175; expenses of land lines, £1,002; stationery and printing, £184. The charges for the use of patents are the same as hitherto. But I am glad to tell you that at about this period, if the time has not already expired, the patent rights of certain patents that we have been using, such as the recorder and the mirror, and other inventions of Sir William Thomson, for which

he has been receiving for 14 years a very handsome income—these patents are about to expire; that will amount to something like £3,000. While parting with these patents, I may say that we owed a great debt of gratitude, and the world owes to Sir William Thomson for these inventions—a lasting debt—because he has enabled submarine telegraphy to be carried to a point which I believe would not have been possible without these valuable inventions. Had the mirror not been invented by Sir William Thomson, then we might be in darkness still, so far as the efficient commercial working of the system of submarine telegraphy is concerned, and I cannot speak too highly of the benefits that we have derived from his great and grand intellect. And there are other items here. There is one very important question, and that is the expenses attending repairs and renewals of cables. The amount expended in the last six months under this head has been £44,815, against £37,113; an increase of £7,702. And, indeed, the question of repairs has always been an important one; and as our cables are naturally growing older, it must become still more serious. But we have endeavoured, in the conduct of this business, to maintain our system in as efficient a manner as possible. We have duplicated a very large extent of our system, and we have done a great deal of that duplication and all repairs out of revenue. That places us at the present time with an efficient system; but, at the same time, a system that requires not only constant care and attention, but which requires additional ships so as to enable us to have those ships placed at proper stations, and so as to be able to avail ourselves immediately of them to effect any repair, because, as you know, we depend for our income upon the efficient maintenance of our system, and we have to maintain that system what I may call consecutively; that is, without any interruptions of the traffic. We find submarine telegraphy a steadily growing system, always growing more rapidly in times of good trade, or in times of any disturbance by war or scares, so that we, to meet these requirements, must not only have our system efficient in the way of duplication and triplication, but must always have efficient ships on the spot to do the work of repairing which is necessary. It will be seen, on reference to the full details of abstract B of the report, that the work done by our ships has been very great, but notwithstanding the necessary repairs, we are able to pay a dividend for the year ending 31st March last of 6 per cent. on the ordinary shares, and carry forward £100,000 to the reserve fund, against £65,000 in the corresponding period of 1884. We have written off this fund a discount and issue of 4 per cent. mortgage debenture stock. We thought that should be written off at once. The general reserve fund now amounts to £397,000; the total reserve fund, including the Sardinian and other cables, is £431,705. Since the year 1877, inclusive, we have taken £442,012 to maintain our system. If we had kept that the reserve fund to-day would have been—instead of £431,000—nearly £900,000, but we think we have done wisely in the course we have pursued. It has enabled us to increase our traffic, and maintain our dividends notwithstanding, as we now announce to you to-day. I referred, at a previous meeting, to the fact that some of our cables were getting old, and during active times it would be absolutely necessary that we should maintain our system in a thoroughly efficient manner. Three months ago, you are aware, there was an important scare, which, I believe, involved the late Government in an enormous expenditure. That was supposed to subside, and we were getting into smoother water again. But only yesterday we had another scare which made a very serious effect upon the stocks in the London market; and, however far that scare might have been justified, the popular opinion seemed to be on the side of the statement having been a correct one. It is not my business here to give any opinion on the politics of the day; but upon this we are all agreed, that it is necessary for us to be prepared for scares of that kind, come when they may, that we should have our system such as to meet the requirements of the Government, and at the same time add to our income by taking advantage of those scares. We have now a duplicated system between Land's End and Malta, and Lisbon and Gibraltar, and Gibraltar and Malta; and our income during the past year has come rather out of the scares I have alluded to, than out of legitimate traffic, which has not been so great as usual. What we contemplate now is to triplicate our line to Malta, and in that case we shall consider ourselves in a sound and safe position. I think that will cost £300,000, and I think we can do that, partly from reserve and partly from other sources. It will make our present position more stable and more permanent, and I think we had better continue to pay our present dividend for a time than to pay you 7 or 8 per cent. to-day, and only 4 or 5 per cent. next year. We think it desirable to put this before you as our policy—we have a definite policy—because we wish to enlist your sympathy and support in carrying out the work. This triplicating has become almost a necessity to meet the emergency of breakages. I have never said anything to you about our breakages, but at the present time we have a cable broken between Gibraltar and Lisbon, another between Suez and Suakim, another between Suakim and Perim, another between Bombay and Aden, and a direct Porthcurno-Lisbon cable; but we have our whole business so thoroughly in hand, and our steamship arrangements are so efficient, that we are very promptly able to carry out repairs, and such are our arrangements that our work goes on almost without any interruption at all. I may say we have just closed a satisfactory arrangement with the Greek Government, who, probably, are more in advance than any other nation in establishing submarine telegraphy. They considered it necessary, and have just closed with us an arrangement for 34

years by which we shall receive £6,500 per annum over 447 miles. A good deal of that cable is such as we have taken up in the course of our repairs and have renovated, and can apply it without saddling the company with great cost. We hope to make arrangements with Turkey for carrying a submarine system for them to their ports in the Red Sea. The Government of Portugal has invited tenders for a cable to the West Coast of Africa, and England has been obliged to follow suit, and I hope we shall be able to report shortly that we have made arrangements with the English Government, and that we have carried a cable from St. Vincent to our settlements on the West Coast of Africa. The Cape Colony offer a subsidy; but that subsidy is not likely to bring about an extension of the cable which will be laid. Every year since the line was established between Zanzibar and Mozambique, we have had some interruption, generally about the same time and in the same place. Now the result of investigation has shown us that this breakage has occurred from the rush of water from two rivers in the vicinity; that the rush of the water has undermined the land upon which the cable was lying, at the bottom of the sea, and so the cable was broken, and always, too, when these rivers were in flood. We have, therefore, now duplicated our cable to satisfy the public of the Cape, to satisfy the telegraphing public generally; for when we considered their interests we thought it almost our first duty to secure for them such a traffic as will secure for us their confidence and their support. That will cost the South African Company something like £120,000, which will be paid out of reserve. I mention this because we are really the interested parties; and so it is with all our colonies. They are greatly interested in all that occurs in England, and any "scare" only increases their desire for news by telegraph concerning affairs in the old country. This shows that there is a good field of enterprise in the colonies. Mr. Pender, in conclusion, referred to the coming annual international conference at Berlin, on the subject of submarine telegraphy, and said he hoped that they might be fairly dealt with when the matter of the comparative cost of land lines and the submarine system was considered. The land line system—the system of Germany—did not connect them with the world at large; they were the parties who did that, and were entitled to the confidence of the conference. If they did not get all their own way through their representative at that conference, it was nevertheless necessary that they should duplicate their system; for if they were to carry more messages, and at a reduced rate, they must have more cables. Mr. Pender then moved the following resolution:—"That the printed report and accounts of the directors to the 31st March, 1885, submitted to this meeting, be and they are hereby received and adopted; that a dividend on the preference shares of the company to the 30th June, 1885, at the rate of 6 per cent. per annum be paid, less income tax; and that, in accordance with the directors' recommendation, a dividend be and is now declared of 2s. 6d. per share, with a bonus of 1s. per share, both free of income tax, on the ordinary shares of the company, making, with previous payments, by way of dividend on account, a total payment of 6 per cent. on these shares for the year ended 31st March, 1885."

The Marquis of Tweeddale (vice-chairman) seconded the motion, which was agreed to; and with a vote of thanks to the chairman the proceedings closed.

The Direct United States Cable Company, Limited.

THE report of the directors for the six months ending 30th June is as under:—

With this report the directors submit the usual statement of account for the half year ending 30th June, 1885, which, with the half year's accounts to 31st December last, presented at the ordinary general meeting on the 5th February last, show the financial result of the eighth year's working of the company.

The revenue for the half year, after deducting out-payments, amounted to £36,106 1s. 1d. against £68,573 8s. 11d. (after similar deductions) for the corresponding period of 1884, being a difference of £32,467 7s. 10d. against the half year under review, owing to the operation of the reduced tariff mentioned in the last report.

The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cable, amounted to £17,206 15s. 11d., leaving a balance of £18,899 5s. 2d. as the net profit of the half year, making, with £17,251 2s. 11d. brought forward from the previous half year, a total of £36,150 8s. 1d.

Two quarterly interim dividends of 1½ per cent. each, and one quarterly dividend of ½ per cent. together amounting to £39,461 10s., have been declared and paid at the usual times during the financial year, and a final dividend of 3s. per share is now proposed, making, with the three interim dividends, 4 per cent. for the year, being a total distribution of £48,568.

The appropriation of the above balance of £36,150 8s. 1d. on the revenue account is thus shown:—

Interim dividend for the quarter ending	
31st March, 1885...	9,106 10 0
Final dividend now proposed	9,106 10 0
Carried to the reserve fund (thereby increasing it to £310,000)...	7,203 13 6
Carried forward to next account ...	10,733 14 7
	£36,150 8 1

A break occurred in our main section of cable on the 27th January last, and was promptly repaired on the 17th February,

the cost of the repair, £2,857 18s. 9d., has been charged against the reserve fund.

Our short section of cable is at present interrupted, but the interruption does not affect the working of the traffic, which passes by the alternative land line between Torbay and New York. The repair will be made as soon as possible.

Montevidean and Brazilian Telegraph.—A meeting was held on the 10th instant, when resolutions were submitted to wind up the Company voluntarily, and to appoint Mr. James Fraser, the secretary, 2, Tokenhouse Buildings, E.C., the liquidator. The liquidator is to be authorised to sell the undertaking, property, and assets to the Western and Brazilian Telegraph Company, in consideration for 2,972 fully paid-up shares of £15 each in that company (being in the proportion of one share of the Western Company for every three shares in the company), the Western Company also undertaking to pay off at par, with interest from the 30th June, 1885, the existing debenture debt of the company, amounting to £12,380.

Direct United States Cable.—A dividend of 3s. per share, free of income-tax, is recommended for payment on the 25th July, making, with the interim dividend already paid, 4 per cent. for the year ended 30th June, 1885. £7,204 has been added to the reserve fund, making it up to £310,000, and £10,734 will be carried forward.

Eastern and South African Telegraph.—The coupons due 1st July, on the 5 per cent. mortgage debentures, are payable at the banking-house of Messrs. Barclay, Bevan & Co., 54, Lombard Street, E.C.

Globe Telegraph and Trust.—A dividend of 3s. per share on the ordinary shares has been declared, payable on the 28th instant, making 4½ per cent. for the year, and £1,792 has been carried forward.

West Coast of America Telegraph.—The coupons due on the 30th of June on the debentures are payable at the office of Messrs. Barclay, Bevan & Co., 54, Lombard Street, E.C.

The Telegraph Construction and Maintenance Company, Limited, announce that the transfer books will be closed from the 13th to the 21st inst. inclusive, preparatory to the payment of an ad interim dividend of 12s. per share.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 10th, were £2,429, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

LEGAL.

Exchange Telegraph Company, Limited, v. Cohen.

—This was an action brought by the plaintiff company, of Cornhill, to recover £14 8s. 9d., as the subscription alleged to be due for the use of their telegraphic instrument between January 1st and June 30th, from the defendant, Mr. Isaac Cohen, of 83, Whitechapel Road. It appeared that in February, 1884, the defendant, who was stated to be the proprietor of a social club known as the Sussex Club, was desirous of having an instrument to wind off on paper tapes news and information which is supplied by various news companies. Accordingly, on February 29th, 1884, an agreement was entered into between the defendant and the plaintiffs that they should supply an instrument which commenced to work on March 25th. The terms were 40 guineas per year for its use, to be paid in two instalments. The defendant paid altogether £21. It appeared that he had another instrument in the club, which had been placed there by the Electric News Company. The defendant paid them 25 guineas for its use up to June of this year. That company went into liquidation, and the plaintiff company bought the business, the defendant being one of the subscribers. The plaintiffs then contended that at an interview with the defendant it was agreed that he (the defendant) should have credit for £19 13s. 9d., the proportionate part which he had paid in advance to the Electric News Company, if he would pay the balance of £14 8s. 9d. due, which was sued for. To this the plaintiffs said the defendant agreed, but the defendant on the other hand denied that any specific sum was mentioned. Capt. Davies, the managing director, threatened to cut off the communication if the money was not paid. Mr. Cohen, the defendant, said he would pay anything reasonable and just and right, but this was not just. Mr. Joseph Lyons, son-in-law of the defendant and manager of the club, corroborated the last witness in saying that no agreement was come to at the interview. They tried to settle the matter amicably. Both the defendant and Capt. Davies, upon leaving, said they would consider the matter. Nothing definite was arrived at, and certainly not to pay £14 odd. The learned Judge summed up, and the jury, after a very short deliberation, found for the defendant. Costs were allowed.

NEW PATENTS—1885.

- 8258. "Electric indicator and alarm to be used in halls, doorways, gateways, &c." J. FYTTON. Dated July 8.
- 8312. "Machine for making electric conductors." J. G. PARKER. Dated July 9.
- 8319. "Generating electricity and apparatus therefor." W. P. THOMPSON. Dated July 9.
- 8321. "Electrical magnet for circular bells and other electrical purposes." H. S. HEATH. Dated July 9.
- 8331. "Carbon element for galvanic batteries." A. M. CLARK. (Communicated by C. E. Goodwin.) Dated July 9.
- 8343. "Extending electrical communicating lines." D. R. DAWSON. Dated July 10.
- 8345. "Dynamo-electric machines." S. W. CUTTRISS. Dated July 10.
- 8410. "Connections for incandescent electric lamps." H. J. HARRIS. Dated July 11.
- 8416. "Constructing electrode frames for secondary voltaic batteries." A. KHOTINSKY. Dated July 11.
- 8428. "Secondary or storage batteries." G. E. DORMAN. Dated July 13.
- 8452. "Telephonic apparatus." J. MUNRO. Dated July 13.
- 8491. "Signalling and switching apparatus for telephonic purposes." A. COLEMAN, F. BROWN. Dated July 14.
- 8511. "Apparatus for signalling on board ship." J. LEA, R. MATTHEWS. Dated July 14.
- 8520. "Construction and arrangement and method of working apparatus for generating and utilising electricity." A. F. ST. GEORGE. Dated July 14.
- 8525. "Telegraphic signalling apparatus." L. DE M. G. FERREIRE. Dated July 14.
- 8528. "Dynamo-electric machines." W. R. LAKE. (Communicated by E. R. Whitney.) Dated July 14.
- 8538. "Electric clock with automatic electric winding apparatus." D. VAN DE PLANCKE. Dated July 14.
- 8540. "Voltaic batteries." F. H. W. HIGGINS. Dated July 14.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

10713. "Improvements in electrical automatic and optical railway signals and locomotive and rail insulation." W. H. BECK. (Communicated from abroad by T. C. Miles, of New York.) Dated July 29. 8d. The object of the invention is to enable a train, while passing the signal posts or semaphores, to bring the arm of the said posts or semaphores into the required position to indicate "danger" or "stop" with no possibility of changing this position of the signal before the train has reached a second post or semaphore, erected at a certain distance from the first. This is done without the use of mechanical contrivances, such as rail treadles and such like, and without employing local batteries.

10996. "Improvements in relay apparatus for electric telegraphs." C. D. ABEL. (Communicated from abroad by J. Kolzer, of Duisburg.) Dated August 6. 8d. Relates to an arrangement of electric telegraph apparatus for transmission from line current to working current by means of polarised relay apparatus described in a provisional specification filed on the 24th January, 1884, No. 2078.

10699. "Regulator for controlling the supply and distribution of electric currents." J. TAVENER. Dated July 29. 4d. A tube terminating in bulbs, similar in principle to a differential air thermometer, partly filled with mercury and partly with air, and hermetically sealed. Inserted in one of the bulbs is a resistance or resistances (connected with a circuit, the whole or part of which it is required to regulate), whose temperature increases with the increase of the current traversing it, thus heating and expanding the air and displacing the mercury, and causing the current, which is to be regulated, to pass through an increasing or decreasing resistance, connected with the mercury, which with the resistance form part of the circuit traversed by the current, which is to be regulated.

11066. "A hydrometer, especially applicable for indicating the electric condition of secondary or storage batteries." T. PARKER. Dated August 8. 6d. This hydrometer operates upon the principle of the hydrostatic balance, and is constructed as follows: To one end of a scale beam, and submerged within the battery solution, is suspended, by a platinum wire or other suitable means, any weight incapable of being acted upon by the solution employed. To the other end of the scale beam is attached an adjustable balance weight, and from the centre of the beam a pointer is carried down to an index face. The balance is adjusted so that the weight within the liquid rises as the battery is charged, that is as the solution therein increases in density. As the submerged weight rises it causes therefore the pointer to

indicate the quantity of electricity charged, and the amount accumulated within the battery. As the battery discharges, and the density of the solution is consequently lessened, the submerged weight sinks within the solution, and the pointer arm therefore indicates a decreased accumulation of electricity within the battery, and consequently also the quantity of electricity discharged. As the submerged weight rises, the pointer arm acts as a counterbalance in the same manner as the pointer of an ordinary chemical balance.

11323. "Improvements in telephones." W. E. IRISH. Dated August 15. 6d. The characteristic feature of the present improvements is that the diaphragm (or equivalent vibrating disc, sheet or plate, whether made of wood, ebonite, thin sheet metal, or other material suitable for the purpose) is supported or mounted, and held, or firmly secured at, or adjacent to its inner or central part, in such a manner as to leave its circumference or outer edges or parts perfect freedom of vibration.

11324. "Improvements in telephone transmitters or circuit interrupters for transmitting articulated speech and other sounds." W. E. IRISH. Dated August 15. 6d. Consists in the combination of a funnel, cone, cup or other suitably shaped insulated holder, containing a series of conducting bars or rods, or of non-conducting bars or rods having contacts of suitable conducting material, or equivalent means, uniformly arranged and secured within such holder with their lower ends or parts close towards but not touching each other, with a conducting ball, or its equivalent, forming part of the electrical circuit, and which freely rests upon and is supported by the said rods or bars, or the said contacts thereof.

11325. "An improved system or method, and means to be used in connection therewith, of receiving and automatically recording articulated speech and other sounds transmitted telegraphically, telephonically, or otherwise by the aid of electricity." W. E. IRISH. Dated August 15. 8d. Comprises various substantially equivalent arrangements of fixed and suspended permanent or electro-magnets, and bobbins, or equivalent means, which are combined with a compressible reservoir of ink or marking fluid, and with flexibly suspended means (automatically operated by such magnets or equivalent means in accordance with the influence of the various sounds electrically transmitted and received by them) of transferring the ink or marking fluid and thereby recording in phonetic signs or characters the varying motions of such magnets or equivalent means on to a moving sheet of paper or its equivalent so that such recorded movements may be clearly and at any time read off in the manner in which ordinary shorthand is read off.

11385. "Improvements in the construction of coils or apparatus for the production and passage of currents of electricity." L. GAULARD and J. D. GIBBS. Dated August 18. 6d. Consists in forming the coils of annular discs with projecting lugs or ear pieces, as described in the provisional specification 3173, February 12th, 1884, as applied to the production of secondary coils, but in place of using a double helix, as there described, the inventors use a coil only for the primary current. They form the discs each with two lugs or ear pieces at either side of a slit in the said discs and extending from the outer circumference thereof.

11393. "Improvements in the construction of armatures for dynamo-electric machines." R. P. SELLON and J. S. SELLON. Dated August 18. 6d. The inventors form the armature core of soft band or hoop iron which is wound upon a suitable ring or support, preferably of wrought iron, which they call the "foundation ring," as it forms a substantial foundation for the first layer of the band iron. The band iron may be wound on to the foundation ring, either in a single spiral or one or more spirals, and these may be either of one or varying widths. This spiral, or these spirals, are preferably in one length, but may be made in several lengths. The inventor sometimes winds or places thin canvas, paper, or some suitable insulating, and preferably incompressible substance, between each layer of the band iron.

12516. "Improvements in galvanic batteries." P. R. DE FAUCHEUX D'HUMY. Dated Sept. 17. 6d. The inventor employs ribbons of iron or steel folded upon themselves as many times as is necessary, either vertically or horizontally and spirally, or any other form. A carbon element is plunged in a depolarising liquid contained in a porous vase or in a hollow carbon, or in any other vase. One extremity of the metal element and one extremity of the carbon element will form the two poles. The depolarising liquid may be pure nitric acid, or sulphuric acid and nitric acid, or sulphuric acid and nitrate of soda, or nitric acid mixed with water. The carbon pole immersed in the porous vase or containing the depolarising liquid, is plunged in pure water contained by or in which the metal element is immersed, the action of endosmosis taking place a very light chemical reaction is generated.

12802. "Improvements in voltaic batteries." D. G. FITZGERALD and T. J. JONES. Dated September 25. 6d. The essential feature of the present invention consists in the conversion of sulphate of lead into spongy lead to form positive elements, and the further conversion of this spongy lead, or of spongy lead from another source into peroxide of lead, for the production of negative elements.

15480. "Improvements in membrane telephones." S. P. THOMPSON and P. JOLIN. Dated November 25. 6d. Have for their object the perfection of telephonic instruments such as are described in the *English Mechanic* of August 11th, 1876, page 551,

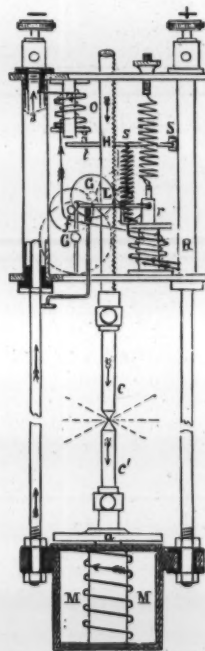
having armatures carried on membranes or drumheads, and the improvements are designed to effect an increase in the sensitiveness and efficiency of the apparatus.

15567. "A new primary battery." A. R. UPWARD and C. W. PRIDHAM. Dated November 26. 4d. The inventors cause a carbon element to be surrounded by broken carbon in a porous cell, and amongst this broken carbon they cause chlorine gas to circulate. They admit the gas by a pipe sealed into the cell, preferably at the bottom, and lead it away by another pipe similarly sealed in at the top, and so convey the gas from cell to cell.

1885.

455. "Improvements in printing telegraphs." G. M. HATHAWAY. Dated January 13. 8d. Relates to a printing telegraph system and apparatus of the class in which rotating type wheels are used in connection with impression devices operated by electro magnets, the object of the improvement being to accomplish the transmission of printed telegraphic messages with increased rapidity as compared with the previously existing state of the art to print at the transmitting station a message simultaneously with its transmission to a receiving station, and to print messages in pages of parallel lines, though the apparatus may be used for printing in a continuous line on a narrow strip or fillet.

639. "Improvements in arc electric lamps." R. P. SELLON. Dated January 16. 6d. In the fig., M, M, is the main magnet fixed at the lower end of the lamp, which, upon the current passing, attracts its armature, a, and draws down the lower carbon, c', thus establishing an arc. The upper carbon, c, is attached to the rack rod, R, which engages with the gearing, G, the gearing terminating in the fly, F, and locked by the lever, L. This lever is attached to the armature core, r, of the spool, X. This spool is wound with fine wire, and in conjunction with the fine wire wound upon the "cut out" spool, O, is connected across the terminals of the lamp, as shown by the light line surrounding either magnet, and is further wound with coarse wire, which is connected with the "cut out" device, t, and the "cut out" spool, o, across the terminals of the lamp, as shown by the heavy



line on the drawing. Thus when, owing to the consumption of the carbon, the distance between their points becomes great, the armature of the "releasing" spool, X, is drawn down and the gearing unlocked, allowing the carbons to approach. When, owing to total consumption of the carbons, or other accidental cause, the distance between the carbon points becomes excessive, so that the circuit is in danger of being entirely broken, the increased current shunted through the fine wire on the spools, R and O, causes the latter spool, O, to attract its armature, t, and establish a short circuit through the coarse wire wound upon both spools. The coarse wire upon the spool, X, which up to such point had been inoperative, will now magnetise and attract its armature core, r, and thus allow the upper carbon to feed down to its full or the desired limit.

2135. "Improved construction of insulators for electric telegraph and telephone wires." W. C. JOHNSON and S. E. PHILLIPS. Dated February 16. 4d. Fig. 1 of the accompanying drawings shows a section of an insulator constructed according to the invention; fig. 2 shows an elevation thereof to a smaller scale, the head,

a, of the insulator, as also the end, b, of the metal stem being inclined away from the direction of the pull exerted by the loop, c, of the telegraph or telephone wire. d is the wire loop for elec-



FIG. 1.

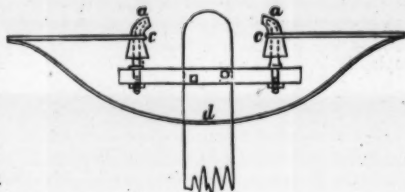


FIG. 2.

trically connecting the wire on one side of the support with the wire on the other side thereof.

2477. "Improvements in repeaters for submarine cables." M. G. FARMER. Dated February 24. 6d. The object of the invention is to provide practicable and efficient means for working repeaters on a submarine cable divided up into several sections without the employment of local batteries at the repeaters. Two wires are used for the purpose.

2575. "Improved means for regulating electromotive force in the various parts of a system of mains used for electric distribution." J. E. H. GORDON. Dated February 25. 4d. It consists, firstly, of a wheel, the surface of which is partly wood and partly metal, and on which press metal brushes connected respectively to the separate component cables of the feeding main. The dynamo current enters the wheel and passes off by all, or less than all, of the brushes, according to the position of the wheel, i.e., according as the brushes press on wood or metal. Consists, secondly, of an apparatus for moving this wheel in accordance with changes of electromotive force at the distant centre, and so as to correct those changes.

CORRESPONDENCE.

Submarine Cable Data.

There was in your issue of May 23rd a question raised under the above title as to the insufficiency of information with reference to the details of the composition of an electrical cable after its submersion, as furnished by contractors in general to the companies for whom the cables have been made and laid.

Now you must be aware that, as a rule, during the manufacture and submersion of an electrical cable, all the separate component parts are submitted to consulting engineers who are engaged by the company for that purpose; the position of such parts in the cable are further under their complete cognisance from its first appearance as core down to its final resting place on the sea bed.

If, then, any official of a cable company considers himself at a loss for any particular information, he can demand that such special details be obtained from the consulting engineers, and the contractors can hardly be called to account in this case.

The foregoing remarks apply to contractors in general, but with regard to cables manufactured by ourselves it has been our practice, when the companies have not been specially represented by consulting engineers, to give to the company direct as full particulars as we ourselves keep of details of the separate component parts.

Thus—to mention the electrical qualities alone—they receive for each coil complete tests at two fixed temperatures (75° and 50° F.), with the insulation in each case up to 10 minutes electrification (the values thus given being especially reliable from the fact of their being the results of several series of tests and extending over a considerable period of time during the process of manufacture). The positions of the coils in the cable as manufactured, then as shipped and finally as laid are given independently, so that each position can be easily checked if necessary.

It is evident, therefore, that with these particulars at hand an electrician could employ himself for many months in working out any special quality or inequality of the cable with the effect it would produce after submersion.

It is not necessary to go into detail as to the other data which we furnish, and which are just as voluminous, but we venture to say that what we do give affords material for a most accurate and detailed account of the position, mechanical and electrical properties of the cable before and after its submersion, and for the reduction of such values to the usual standards.

Siemens Bros. & Co., Limited.

L. LOEFFLER, Managing Director.

12, Queen Anne's Gate, Westminster,
London, S.W., July 11th, 1885.

Radiations Emitted by Incandescent Carbons.

The conclusion arrived at by M. Felix Lucas in his recent communication to *Les Comptes Rendus* should not be allowed to pass unchallenged without some further grounds than are there given.

Mr. Preece has found that the luminous radiations emitted by incandescent lamps are proportional to the sixth power of the current, subject to a coefficient, and this has been proved both by experiment and theory by Capt. Abney, and is the result arrived at by the Munich tests.

The spectrum of a body as it rises from red heat to white heat gradually extends from the red to the violet, and beyond to the actinic regions, but no one has hitherto noticed, or at all events published the fact that at the higher stages of incandescence there is any falling off of the red rays.

No experiment of this kind is of much value unless the actual volts are given, that the watts, not the ampères, may be compared with the radiations. It appears very probable from the look of the curve alluded to by M. Lucas, that the radiations continually increase, probably as some power of the watts, and that the falling off which begins to be noticeable after 150 ampères is due to some obscuration produced by volatilisation of the carbon which might be expected at that temperature, and which would, unless specially provided against, be quite sufficient cause for the decrease. There is evidently some error at 165 and 175 ampères, and it would be interesting to know how the "three to seven experiments" agreed among themselves. The results seem quite at variance with Capt. Abney's researches.

Alex. P. Trotter.

Bull Green Works, Halifax,
July 13th, 1885.

"Secondary Batteries."

One word more upon this subject and I have done. Will the Electrical Power Storage Company answer the following questions?

(1) Is it not a fact that in all cases where the E. P. S. Co. have put up installations, the main switch (designed and made by them) used for putting in or cutting out a cell, *short circuits* that cell every time it is used?

(2) Will they explain how it is that fatal injury is not done to the cells in this case, as well as when short circuiting them momentarily to test them?

(3) Are the E. P. S. Co. prepared to guarantee their batteries for, say, three years? For on their own showing, they require no skilled labour, overcharging cannot hurt them, buckling of the plates is prevented, and lastly, short circuiting through switches recommended, as evidenced by their show at the Inventions Exhibition.

F. Geere Howard.

Cleveland Works, W.,
July 14th, 1885.

PATERSON & COOPER, **ELECTRIC LIGHT AND POWER AND TELEPHONE ENGINEERS,**

ST. PAUL'S WORKS—78, LITTLE BRITAIN, LONDON, E.C., AND
EUROPEAN TELEGRAPH WORKS—POWNALL ROAD, DALSTON.

Prize Medals, International Electrical Exhibition, Paris, 1881, London, 1882, and Calcutta, 1884.

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